Accelerated Breeding (ABI):
Meeting farmers' needs with nutritious, climate-resilient crops

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Proposal

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Contents

- Annexes
- References

List of acronyms

ABI:	Accelerated Breeding: Meeting Farmers' Needs with Nutritious, Climate-Resilient Crops
BPAT:	Breeding Program Assessment Tool
CapDev:	Capacity Development
CIMMYT:	International Maize and Wheat Improvement Center
CIP:	International Potato Center
ClimBeR:	Building Systemic Resilience Against Climate Variability and Extremes
CtEH:	Crops to End Hunger
DG:	Director General
EiB:	CGIAR Excellence in Breeding Platform
GxE:	Genotype by Environment Interaction
GDI:	Gender, diversity and inclusion
GI:	Genetic Innovation
GREAT:	Gender-responsive Researchers Equipped for Agricultural Transformation
GS:	Genomic Selection
Ha:	Hectares
HH:	Household(s)
IA:	Impact Assessments
IAG:	Investment Advisory Group
IITA:	International Institute of Tropical Agriculture
IP:	Innovation Package
IRRI:	International Rice Research Institute
KPI:	Key Performance Indicators
M & E:	Monitoring and Evaluation
MELIA:	Monitoring, Evaluation, Learning and Impact Assessment
MIPP:	Market Intelligence and Product Profiling
N4ETTS:	Network 4 Enabling Tools, Technologies, and Shared Services
NARES:	National Agricultural Research and Extension Services
NARS:	National Agricultural Research Systems
OFSP:	Orange-flesh sweet potatoes
PHRRFLS:	Plant Health and Rapid Response to Protect Food and Livelihood Security
Q:	Quarter
QG:	Quantitative Genetics
RACI:	Responsible, Accountable, Consulted, Informed
ROI:	Return on Investment
SDG:	Sustainable Development Goals
SeEdQUAL**:**	Delivering genetic gains in farmers' fields
SHF:	Sustainable Healthy Diets through Food Systems Transformation
SME:	Small and medium-size seed enterprises
SSA:	Sub Saharan Africa
TBD:	To be Decided
TD&D:	Trait Discovery and Deployment
TOC:	Theory of change
TPE:	Target population of environments
USAID:	United States Agency for International Development
VIN:	Variety Identification Number
WP:	Work Package

Summary table

Initiative name	Accelerated Breeding (ABI): Meeting Farmers' Needs with Nutritious, Climate-Resilient Crops
Primary Action Area	Genetic Innovations
Geographic scope	Global
Budget	US$ 109,000,000

1. General information

Initiative name: Accelerated Breeding Initiative (ABI)
Primary CGIAR Action Area: Genetic Innovation
Proposal Lead and Deputy: Michael G. Quinn and Clare M. Mukankusi

Initiative Design Team (IDT) members and affiliations:

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29.	Michael Baum	CGIAR	Extended advisory
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31.	Monica Menz	Syngenta / EiB Platform Steering Committee	Extended advisory
32.	Nora Lapitan	United States Agency for International Development (USAID)	Extended advisory
33.	Paul Gibson	Makerere University Regional Center for Crop Improvement (MaRCCI), Uganda	Extended advisory
34.	Pradeep Kumar Singh	Indian Agricultural Research Institute (IARI), Indian Council of Agricultural Research (ICAR)	Extended advisory
35.	Prasanna Boddupalli	CGIAR - Maize	Extended advisory
36.	Ram Baran Yadaw	Nepal Agricultural Research Council (NARC)	Extended advisory
37.	Ramlakhan Verma	National Rice Research Institute (NRRI) of Indian Council for Agricultural Research (ICAR)	Extended advisory
38.	Taye Tadesse	Ethiopian Institute of Agricultural Research (EIAR)	Extended advisory

2. Context

2.1 Challenge statement

The overarching goal of ABI and of GI is to deliver higher rates of genetic gain in the form of farmer-preferred varieties and to decrease the average age of varieties in farmers' fields providing real-time adaptation to climate change, evolving markets and production systems. The challenge is that many farmers in target geographies are growing very old (>20-40 years) varieties, and therefore not benefiting from recent breeding efforts. To trigger timely adoption, new varieties must offer a step-change in performance that can only be achieved through higher rates of genetic gain than are currently being achieved. Historically, adoption of improved varieties has occurred readily due to the obvious value proposition associated with improved plant type, disease resistance or quality. However, the breeding methods that achieved the previous generations of improved varieties will not deliver the step-change in performance for the complex traits that are now needed to achieve the projected benefits for the five Impact Areas. Including traits related to:

increased production under diverse environmental conditions inhabited, and crop management practices used, by smallholders; climate resilience; biofortification; processing characteristics, end-use quality and consumer preferences; and those that address the needs of women, youth and children. This will require a quantitatively optimized and data-driven approach to breeding, faster breeding cycles and greater focus on development of farmer- and consumer- preferred varieties adapted to distinct production environments, markets and end uses. Furthermore, moving to more focused breeding approaches that align with impact goals within target geographies is a prerequisite to aligning CGIAR breeding efforts with funder priorities and for maximizing benefits to the five CGIAR Impact Areas. This has never been possible in CGIAR due to the lack of a single, standardized approach to assessing opportunity for impact across crops and centers. One CGIAR and GI now offer this opportunity, as Market Intelligence and Product Profiling (MIPP) define the impact case – and the work described by this Initiative enables the implementation.

Currently, National Agricultural Research and Extension Services (NARES) partners, particularly in sub-Saharan Africa, have varied levels of capacity with the majority lacking the ability to handle all processes required to develop improved crop varieties that will be adopted by farmers and a few having appreciable levels of capacity. As such, there has been a heavy reliance on CGIAR for variety development by the weaker NARES while at the same time a growing state of competition between strong NARES and CGIAR. NARES wish to have stronger input into CGIAR breeding strategies. The challenge is to increase NARES breeding capacity and enable them to influence CGIAR breeding strategies. Existing CGIAR-NARES networks need to be modified so they appreciate the comparative advantage of each partner and promote growth. These networks must also involve the emerging breeding capacities in local small and medium-size seed enterprises (SME). Higher rates of genetic gain can only be achieved with a change in approach to testing candidate variety performance that is broader and more representative of farmers' conditions and end-user preferences. These goals can be facilitated by closer breeding partnerships between CGIAR, NARES and SME, designed as win-win for all.

2.2 Measurable 3-year (end-of-Initiative) outcomes

In collaboration with the other GI Initiatives, ABI targets the following key outcomes:

- Strongly increase the rate of genetic gain delivered to farmers in the form of preferred varieties to 1.5% per annum by 2030 for productivity while other targets will be used for other traits.
- Reducing the area-weighted average age of varieties in farmers' fields to less than 15 years by 2030.

By 2024, ABI aims to achieve five principal outcomes with the targeted breeding programs and networks:

1. 75% of breeding pipelines are be oriented towards specific market segments, enabling greater focus on farmers' needs, drivers of adoption, and, distinct Impact Areas, and the strategic allocation of resources for maximum impact.
2. 70% of breeding pipelines will use a revised organizational framework that provides operational clarity and effectiveness for specialized teams pursuing breeding outputs.
3. 80% of the breeding networks are have implemented documented steps toward stronger partnership models where NARES and SMEs have increased breeding capacity, and make greater scientific, operational and decision-making contribution to the breeding process.
4. 50% of breeding pipelines are supported by a dedicated discovery and trait deployment (TD&D) program that will deliver high-impact traits in the form of elite parental lines.

5. A least 70% of breeding pipelines have increased the rate of genetic gain in the form of farmer-preferred varieties. With at least 50% providing candidate varieties with step change in performance under farmers' conditions, to seed systems actors or the variety release system.

Together, these five outcomes take transformative steps toward more impactful breeding and the 2030 outcomes through improved focus, science, and empowering partnerships.

2.3 Learning from prior evaluations and impact assessments (IA)

The design of the Initiative benefited from extensive discussions among the Excellence in Breeding Platform (EiB), funders of the Crops to End Hunger (CtEH) Initiative and implementers. These were based around standardized, externally managed Breeding Program Assessments (BPAT) of almost all CGIAR and several national breeding programs. BPATs provide "a structured review of key technical, capacity and management components of plant breeding programs," and have been implemented by breeding- and crop-specific experts since 2017. Funders and implementers agreed on six major objectives to modernize public plant breeding in lower-income countries, referred to as "CtEH Objectives" for modernized CGIAR-NARES breeding:

i. Align breeding pipelines with market segments, product profiles and distinct pipeline investment cases.
ii. Assess and incentivize breeding teams with measures of genetic gain and variety turnover.
iii. Link breeding programs with effective delivery mechanism to farmers.
iv. Optimize breeding pipelines and operations for increased rates of genetic gain.
v. Use shared services.
vi. Develop NARES capacities through more inclusive partnerships.

To ensure integration with seed systems, CtEH commissioned a White Paper, consulting seed sector experts. The White Paper advised breeders to:

i. More narrowly focus product profiles on market-demanded traits.
ii. Engage downstream partners earlier in evaluating results or testing.
iii. Scale up evaluations under farmers' management conditions to ensure new varieties provide substantially greater value to farmers.
iv. Adjust CGIAR breeding networks so they more purposefully evolve NARES and SMEs towards a situation where local resources and breeding program capacities will become adequate to develop elite varieties for distinct crops and markets.

2.4 Priority-setting

Current crop-specific breeding objectives and associated product profiles were informed by: national priorities; stakeholder feedback from NARES, seed companies and farmers; structured household surveys on requirements of men and women farmers; pest and disease surveys; climate change models; and/or benefit estimates such as done for biofortified crops. By starting with specific problems to be addressed (e.g. poverty of smallholder farmers in Nigeria) to which breeding can contribute to the solution, MIPP's and ABI's objective is for each individual breeding pipeline to pursue 1-2 very specific impacts, as described in Section 5, for a well-defined target group of growers and/or consumers. The aim is for the breeding pipelines to collectively, across crops and regions, constitute a breeding portfolio with the greatest total benefit across the five Impact Areas. The strongest emphasis will be on "targeted" pipelines; that is staple crops and legumes with multi-country importance in Sub-Saharan Africa and South Asia where the greatest poverty and malnutrition occurs (Wiebe et al., 2021), while drawing on the strength of CGIAR's global germplasm base and breeding activities. Likewise, these pipelines will be where ABI first starts to implement the changes described in the Work Packages and Results Framework.

Going forward, MIPP will further assess the contribution of each breeding effort to the five Impact Areas in a much more targeted way than has ever occurred in CGIAR, including for crops and traits most important for women, young adults and marginalized groups. Understanding projected impacts and therefore prioritization will also be informed by Plant Health and Rapid Response to protect Food and Livelihood Security (PHRRFLS), for most devastating pests and diseases, and the latest climate models (from Building Systemic Resilience against Climate Variability and Extremes – ClimBER). This enables breeding investments to be focused where the largest production shortfalls can be restored or averted. Sustainable Healthy Diets through Food Systems Transformation (SHiFT) will provide valuable insights into strategies that would support a food system transformation to more sustainable, healthier diets. All these insights together, combined with input from funders, countries and civil society as aggregated by GI and RII, will influence the relative emphasis on breeding pipelines, systematically increasing the total benefit across the portfolio.

This prioritization provides a framework with direction for all CGIAR crops in all regions. Changes to product profiles and breeding pipelines will be implemented progressively as new insights are forthcoming.

2.5 Comparative advantage

CGIAR breeding is unique. It has access to, and in-house knowledge of, the widest genetic diversity of food crops most relevant to low and lower-middle income countries. It has developed elite germplasm and breeding programs specifically designed to meet the needs of these regions and to respond to critical threats, new pests and diseases, weather variability and climate change, malnutrition and inequity. These breeding goals are complex and not fully pursued in national or private breeding efforts, particularly not for markets in low and lower-middle income countries.

Private breeding investments in these regions are limited to the most attractive crops and markets where farmers routinely purchase seed. Due to limited competition, varieties are kept on the market for more than 20-30 years, allowing larger seed companies to minimize breeding investments. National breeding programs are challenged by diverse crops and market segments that cannot all be served through national efforts and with very limited resources. CGIAR is able to join efforts across country borders and also with innovation partners. These critically important partnerships would be very difficult and time-consuming to re-create.

Improved varieties must be developed in the context of current and future farming systems, in support of improved and resilient agrifood systems, and with support from, and alignment with policy development and strategies for food, land and water. Under One CGIAR, the Genetic Innovations Action Area and ABI are uniquely positioned to partner with NARES and SMEs to design, develop and deliver breeding products within this broader context.

2.6 Participatory design process

This proposal is the result of a highly participatory and collaborative process spanning more than three years. In collaboration with EiB, CGIAR breeding programs and several NARES developed improvement plans detailing the specificity (region, crop, institution) and reflecting the complexity (crop biology / use, trait prioritization, interdependencies) of accelerating genetic gains, and defined their ambitions, to:

- Align breeding programs with market segments, target population of environments and product profiles.
- Optimize breeding schemes, shorten breeding cycle time, and increase accuracy.
- Incorporate current best practices to support optimization of breeding schemes, e.g., through genomics-assisted breeding, increased mechanization and digitization, and the use of

purpose-built data management systems (Breeding Management System, Enterprise Breeding Systems, BreedBase).

Since June 2020, Director General (DG) delegates representing each CGIAR breeding center have met monthly with EiB and CtEH funders to discuss progress toward implementation, challenges, and approaches for responding to the CtEH objectives. These discussions led to funders, DG delegates and EiB jointly analyzing topics such as routine measurement of genetic gains, implementing improved partnership models with NARES, understanding the focus of each breeding pipeline in the context of market segments and the expected impact ("pipeline investment case"), and implementing operations models providing centralized services to breeding teams. These discussions led to a better understanding of the current state, challenges, opportunities, ambitions of "what is possible," and of current best practices within CGIAR breeding programs—all of which have been incorporated into this proposal.

The proposal is built around prior evaluations and assessments, as described in section 2.3, which individually resulted from highly participatory processes. For example, the CtEH Objectives were developed by many of the Investment Advisory Group (IAG) members. Similarly, the BPAT report recommendations are based upon in-depth conversations with breeding teams and co-created plans for change, resulting in the prioritized improvement plans. BPAT conclusions were an important source of data for the CtEH Technical Advisory Group and captured in the challenge (2.1) and priority setting (2.4) sections. From this, the CtEH Objectives and the CtEH implementation mechanism led by EIB were developed. This proposal is the continuation of this process toward more impactful CGIAR breeding.

During pre-concept and proposal development, representatives from across CGIAR and for each crop, important NARES, regional and university partners from Africa and South Asia, and funders; provided systematic input and feedback, starting with raw drafts. This consultative process resulted in participatory development of the ABI proposal incorporating priorities and needs of key stakeholders (CGIAR, NARES, regional research bodies, advanced centers of learning) as reflected by partner letters of support. Twenty-one National and Regional Agricultural Research Organizations provided letters of support.

2.7 Projection of benefits

The projections below transparently estimate reasonable orders of magnitude for impacts which could arise as a result of the impact pathways set out in the Initiative's Theories of Change. Initiatives contribute to these impact pathways, along with other partners and stakeholders.

For each impact area, projections consider breadth (numbers reached), depth (expected intensity of effect per unit) and probability (a qualitative judgement reflecting the overall degree of certainty or uncertainty that the impact pathway will lead to the projected order of magnitude of impact).

Projections will be updated during delivery to help inform iterative, evidence-driven, dynamic management by Initiatives as they maximize their potential contribution to impact. Projected benefits are not delivery targets, as impact lies beyond CGIAR's sphere of control or influence.

Impacts of genetic innovations materialize when improved varieties are adopted by smallholder farmers, including women. All initiatives in the **GI Science Action Area** jointly contribute to more efficient and faster development, release, dissemination, and adoption of improved, in-demand varieties through common impact pathways. Besides producing and delivering better quality seed to target beneficiaries in priority market segments, the proposed work aims at modernizing and transforming the genetic innovation system (Figure 1). Selected examples across all five impact

areas show the aggregated projected benefits of all initiatives working in collaboration and contributing at different stages along the impact pathways.

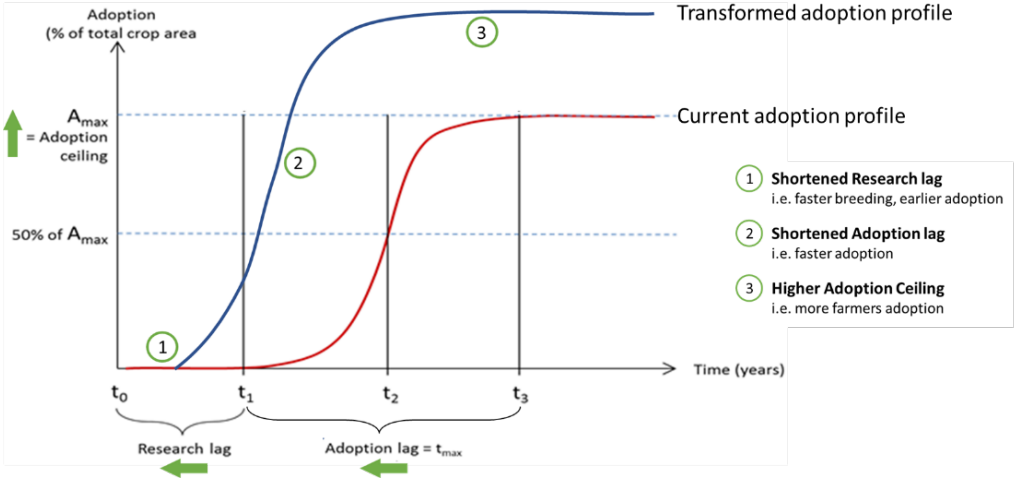


Figure 1. *Adoption profile impact of GI Initiatives*

Market intelligence shortens the adoption lag and increases adoption levels as new varieties are targeted to specific market segments. This leads to faster and more complete replacement of existing varieties and accelerated varietal turnover. Investment in **genebanks** reduces the research lag by making germplasm available to breeding programs, reducing the search time and cost for traits. In addition, potentially game-changing traits are preserved and made accessible, thus elevating future impact-levels. Development of improved varieties with producer/consumer-demanded traits improves livelihoods and food security. Modernized strategies and approaches **accelerate breeding**, thus reducing the research lag, and generating multiplier effects on the benefits from breeding and seed systems. Improved tools and services enable breeders to create more complex, multi-trait products that match desired product profiles. Modernizing **enabling tools and services** increase the speed of breeding, thus shortening the research lag and accelerating variety release. Efficient **seed delivery** accelerates and increases adoption as targeted products reach – even disadvantaged - farmers faster. Moreover, enabling access to high-quality, clean seed and planting material ensures the potential of genetic innovations is realized in farmers' fields.

Examples of Projected Benefits by Impact Area: the below table provides as examples five projected benefits included in the portfolio of benefits pursued by GI. Once established, MIPP will analyze and publish the projected benefits for each breeding pipeline supported with common funding in GI.

Examples of Projected Benefits by Impact Area

Breadth	Depth	Probability
Impact Area: Nutrition, health & food security **Impact Indicator:** # people benefiting from relevant CGIAR innovations		
Higher yielding Vit A rich cassava: 19.5 million people (3.9 million HH) *Orange-flesh sweetpotato*: 14.8 million people (3.1 million HH)	**Significant**: 10% permanent impact on income; some DALYs saved.	**High certainty**: 50 – 80% expectation of achieving these impacts by 2030, at this point
TOTAL: > 23.1 million people (> 4.7 million HH)		

Impact Area: Poverty reduction, livelihoods & jobs **Impact Indicator:** # poor people benefiting from relevant CGIAR innovations		
Higher yielding rice: 12.3 million poor people (2.8 million poor HH) *Stress tolerant maize*: 24.5 million poor people (5.2 million poor HH) *Higher yielding wheat*: 10.0 million poor people (1.9 million poor HH) **TOTAL: > 42.6 million poor people** (> **9.0 million poor HH)**	**Significant** 10% permanent impact on income	**High certainty**: 50 – 80% expectation of achieving these impacts by 2030, at this point
Impact Area: Gender equality, youth & social inclusion **Impact Indicator:** # women benefiting from relevant CGIAR innovations		
High yielding fast cooking Beans: 1.8 million women producers > 3.4 million women in adopting HH *Orange-flesh sweetpotato*: 1.5 million women producers **TOTAL: > 2.5 million women producers** **> 3.4 million women/girls in all adopting HH**	**Significant**: 10% permanent impact on income	**High certainty**: 50 – 80% expectation of achieving these impacts by 2030, at this point
Impact Area: Climate adaptation & mitigation **Impact Indicator:** # people benefiting from climate-adapted innovations		
Stress tolerant maize: 69.9 million people (14.7 million HH)	**Significant**: 10% permanent impact on income	**High certainty**: 50 – 80% expectation of achieving these impacts by 2030, at this point
Impact Area: Environmental health & biodiversity **Impact Indicator:** # plant genetic accessions available and safely duplicated		
Aggregate increase to 2030: 15% (70,000 additional accessions become available)	*Not required for this indicator*	**Very high certainty**: >80% expectation of achieving these impacts by 2030, at this point in the design process

1. **Nutrition, health, and food security:**

 # People benefiting from relevant CGIAR innovations: Vitamin A deficiency is a major disease affecting 48% of children aged 6–59 months in SSA (Stevens et al., 2015). We project that the nutrition, health and food security status of about 23.1 million people (i.e., 4.7 million households) in 16 SSA countries will improve significantly through the adoption of yellow cassava varieties with high β-carotene (precursor of Vitamin A) content and high dry matter, and orange-flesh sweetpotatoes (OFSP) with high β-carotene and improved productivity (details in Annex). Benefits for adopting households arise through increased production, consumption, and sale of crops with higher nutritional value. The number of beneficiaries is projected using crop/country specific adoption profiles based on past evidence and expert estimates, secondary data on national crop production area (narrowed down to target domains), average household size, and crop area per HH. We did not include benefits arising for consumers when biofortified crops are sold. The combined total number of beneficiaries accounts for an estimated 80% overlap (HHs growing both cassava and sweetpotatoes) in 8 countries included in both projections. Projected impact is in the lower bound of high certainty, since dissemination and adoption of the varieties may challenge available seed systems and face market constraints in some countries.

2. **Poverty reduction, livelihoods, and jobs**

 # Poor people benefiting from relevant CGIAR innovations: By enabling poor smallholder households to achieve higher yields and hence 'living income', adoption of improved varieties of rice, wheat and maize is expected to significantly benefit 42.6 million poor people (9 million poor

HH) by 2030 (details in Annex). While the GI initiatives have identified 12 priority crops for breeding, only three innovations (higher yielding rice in South and Southeast Asia (Kumar et al., 2021); high yielding wheat in South Asia Juliana et al., 2020; Crespo-Herrera et al., 2017); and stress-tolerant maize in Sub-Saharan Africa (Cairns and Prasanna, 2018; Prasanna et al., 2021)) are included in the projection. These varieties are at an advanced stage, almost ready to be released and benefits are expected to materialize soon and with high certainty. The number of poor people benefiting is estimated by multiplying the projected number of adopters by 2030 in each country with the poverty headcount ratio at national poverty lines (World Development Indicators, most recent year available). To avoid double-counting in the projected total number of beneficiaries, we accounted for the overlap, especially in the Indo-Gangetic Plain, where HHs frequently grow both rice and wheat (Bhatt et al., 2016), by reducing numbers accordingly (based on Ladha et al., 2003; Timsina and Connor 2001).

3. **Gender equality, youth, and social inclusion:**

 # Women benefiting from relevant CGIAR innovations: While approximately half of all beneficiaries of improved varieties are women, the GI initiatives focus on crops/traits explicitly aiming at improving women's livelihoods. Two examples are bean varieties with increased yield and reduced cooking time (Katungi et al., 2018; Letaa et al., 2020) and orange-flesh sweetpotatoes (Mudege et al., 2017). Women are benefiting from these varieties through different impact pathways: i) increase of income if grown as "women's cash crops"; ii) fast cooking (targeted 30% reduction) benefits women by freeing time, since collection of firewood and meal preparation are mostly conducted by women; and iii) health benefits for women and youth consumers. For our benefit projection, we focus on i) and ii) and follow the general steps outlined for indicators above, and then compute the share of women producers among all adopters (details in Annex). For the 'time saving' benefit, we assume one woman/girl benefits per adopting HH. Since most HH in SSA cultivate several crops, we use an 80% overlap for countries included in both crop projections. We project that at least 2.5 million women producers and 3.4 million women/girls in adoption HH will benefit significantly and with high certainty from these two crops in the included 17 countries alone.

4. **Climate adaptation and mitigation**

 # People benefiting from climate-adapted innovations: The projection of beneficiaries from climate-adapted innovations is derived from the number of farmers in Sub-Saharan Africa adopting maize varieties tolerant to abiotic stress (details in Annex). Droughts have become an almost regular occurrence in SSA, severely reducing yields of many crops (Ray et al., 2015). Maize is an important staple crop in the region and the new drought and heat resistant varieties (Cairns and Prasanna, 2018; Prasanna et al., 2021) achieve 20% higher yields under drought conditions (Setimela et al., 2017). This effect is on the upper end of the "significant" depth criteria in terms of % permanent increase in income. We assume an s-shaped logistic adoption function and use country-level rates of current adoption of improved varieties as adoption ceilings (Krishna et al., 2021), in some cased adjusted upward thanks to significant recent donor investment in the seed sector in target countries. With first adoption by farmers expected in 2022 and an estimated 10-year period to maximum adoption, we project that by 2030 about 14.7 million HH across the target domain will be adopting these improved varieties. This translates to at least 69.9 million persons benefiting from this climate-adapted innovation over the next 9 years.

5. **Environmental health and biodiversity**

 # Plant genetic accessions available and safely duplicated: CGIAR Centers have an obligation to conserve and make available crop collections under their management, according to the provisions of the Plant Treaty. Making accessions available for international distribution requires germplasm to have acceptable viability, be free of quarantinable diseases, with adequate stock, and legally available. In 2020, CGIAR genebanks were managing a total

collection of 592,257 crop and forage accessions[1] (with 79% available for international distribution). By 2030, CGIAR genebanks will achieve (and maintain) 90% availability (i.e., an additional 70,000 accessions becoming available – see details in Annex).[2] The genebanks will process backlogs (e.g., health testing and cleaning, seed regeneration, verifying trueness-to-type, etc.) to reach this performance target.[3] Achieving and maintaining 90% availability enables genebanks to operate at a steady, efficient state, making them eligible for endowment funding, as well as ensuring users have access to germplasm. The effects of the pandemic and examples such as ICARDA's evacuation from Syria illustrate the importance of sustaining performance targets (Westengen et al. 2020).

[1] Not including ICRISAT and CIFOR-ICRAF

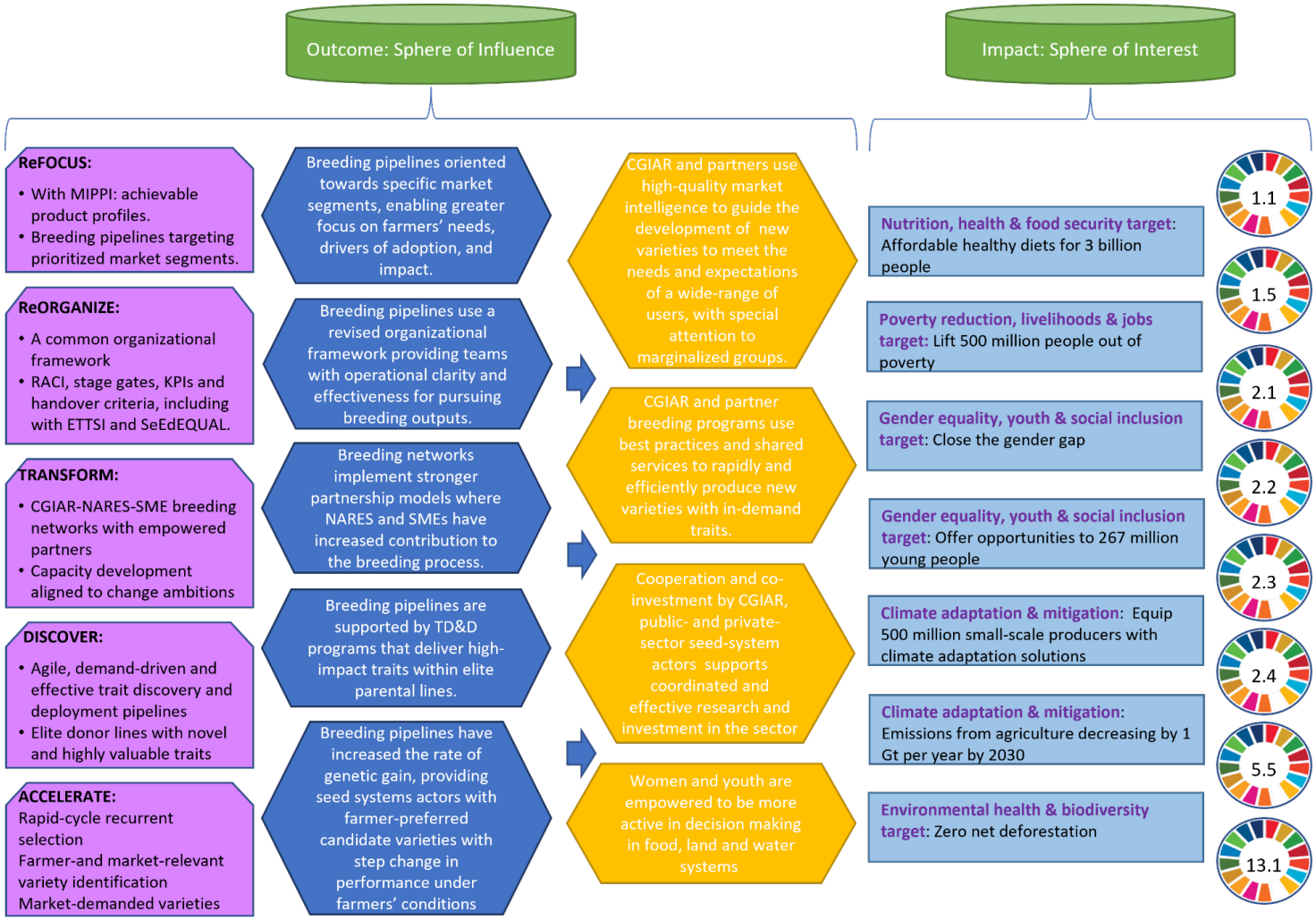
[2] Progress is monitored through an online reporting tool (managed by the Global Crop Diversity Trust), and reported in the annual Genebank Platform reports: https://www.genebanks.org/resources/annual-reports/

[3] 2020 Genebank Platform Annual Report, pp-20-21. https://www.genebanks.org/wp-content/uploads/2021/06/2020-Genebank-Platform-Annual-Report.pdf

3. Research plans and associated theories of change (TOC)

3.1 Full Initiative TOC

3.1.1 Full Initiative TOC diagram



3.1.2 Full Initiative TOC narrative

The overall purpose of the Initiative is to increase the contribution that CGIAR plant breeding makes to improving livelihoods, nutrition, and climate adaptation, while addressing equity and sustainability concerns. Building on Crops-to-End-Hunger (CtEH), **the Initiative intends** to transform CGIAR-NARES breeding to greatly increase the rate of genetic gain for key traits while significantly improving the benefit of new varieties to farmers and consumers, women, and marginalized groups, thereby contributing to driving down the age of varieties in farmers' fields.

The Initiative works with MIPPI and SeEdQUAL to define a portfolio of prioritized product profiles that are informed by smallholder and market demands and, when adopted, have a high probability to create distinct and large-scale development impact. The Initiative empowers CGIAR-NARES-SME breeding teams to be more effective in implementing best-practice approaches to pursue the prioritized set of product profiles and develop climate-resilient, nutritious, market-demanded varieties. In collaboration with N4ETTS, it develops knowledge and skills among CGIAR, NARES and SME actors to: (i) execute effective, demand-focused trait discovery and deployment pipelines, (ii) more rapidly improve breeding populations through accelerated breeding cycles, and (iii) extract and identify farmer-and market-relevant varieties with higher accuracy, including through cross-referencing with farmers' and scaling partners' feedback, facilitated by SeEdQUAL. In addition, the Initiative will jointly review and revise organizational structures, partnership approaches, responsibilities, and decision-making processes to (i) increase ownership among all partners and research teams, (ii) capitalize on the specialized skills, human and operational capacity that exist across institutions, (iii) effectively utilize N4ETTS tools and services, and (iv) more readily attract and retain women professionals, young scientists, and innovation partners.

Through this approach, the Initiative intends to achieve **the End-of-Initiative Outcomes** as they are described in Section 2.2. and depicted in the Theory-of-Change Diagram (3.1.1), in CGIAR-NARES-SME breeding networks that work on staple crops and legumes with multi-country importance in Sub-Saharan Africa and South Asia where the greatest poverty and malnutrition occurs.

The Initiative will contribute to the following Action Area outcomes:

1. CGIAR & partners use high-quality market intelligence to guide the development of new varieties to meet the needs and expectations of a wide-range of users, with special attention to marginalized groups.
2. CGIAR & partner breeding programs use best practices and shared services to rapidly and efficiently produce new varieties with in-demand traits.
3. Cooperation and co-investment by CGIAR, public- and private-sector seed-system actors supports coordinated and effective research and investment in the sector.
4. Women and youth are empowered to be more active in decision making in food, land and water systems

By influencing these changes, and in collaboration with the other Genetic Innovation Initiatives, the Initiative will contribute to the following **long-term outcomes** (by 2030):

1. CGIAR-NARES-SME breeding networks will be able to greatly increase genetic gains and develop varieties with traits that satisfy farmer and market demand.
2. Seed-sector actors' investments will be profitable and effective in scaling-up CGIAR and NARES varieties, driving down the age of varieties in farmers' fields.
3. Farmers will have wider access to, and use much improved climate-resilient, nutritious, market-demanded crop varieties.
4. Public breeding investments are oriented to support varietal development with high potential for improving nutrition, poverty reduction, gender equity, climate adaptation or mitigation, environmental sustainability,

By contributing to these outcomes, the Initiative will support the achievement of **SDG targets** 1.1, 1.5, 2.1, 2.2, 2.3, 2.4, 5.5, 13.1.

Crop varieties are **highly scalable innovations**, the development of will be more systematically informed by scientific evidence and expertise from national partners, seed system actors, farmers, consumers and value chain participants. Seed system actors and national partners, crucial for scaling, will become active drivers of the innovation process and, facilitated by SeEdQUAL, more successful in implementing adaptive scaling strategies for forthcoming crop varieties.

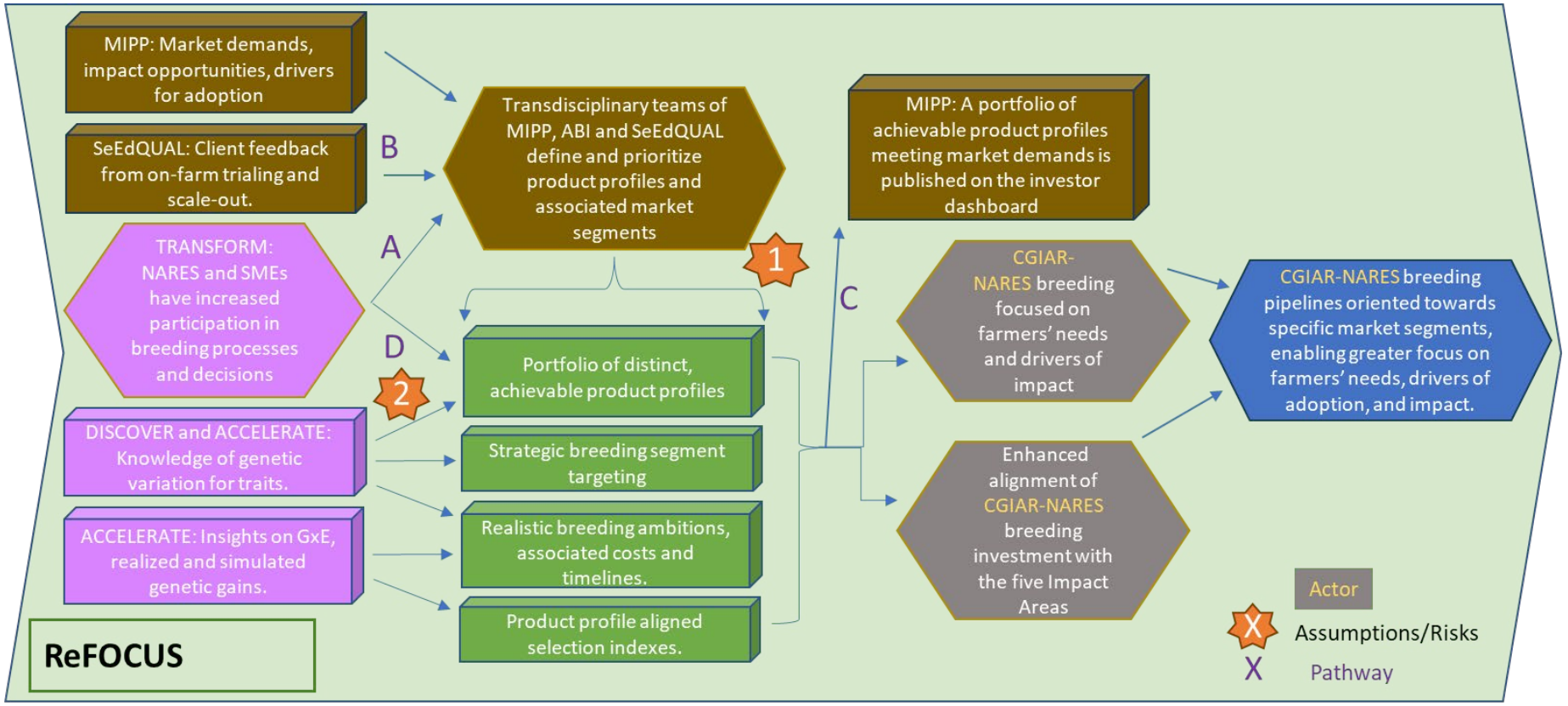
The following **key assumptions** underpin the theory of change

- Seed system actors will experience an increasingly conducive policy environment.
- Farmers will be able to increase incomes from market-demanded varieties.
- Market, household, seed sector and impact studies help to incrementally improve the focus of breeding pipelines, to serve feasible impact pathways that create large scale benefits.

3.2 Work Package TOCs

3.2.1 Work Package TOC diagrams

TOC *diagram* for ReFOCUS



3.2.2 Work Package research plans and TOCs

3.2.2.1 ReFOCUS: Aligning breeding teams and breeding objectives with farmers' needs.

WP 1 title	**ReFOCUS: Aligning breeding teams and breeding objectives with farmers' needs.**
WP main focus and prioritization	The Market Intelligence and Product Profile Initiative (MIPP) and ReFOCUS will jointly work on: • Iteratively adapting and evolving product profiles that best meet the needs of a given target group of customers, and are feasible to achieve through genetic improvement. • Developing a clear priority setting among product profiles pursued, target regions, and relationships to the five impact goals ReFOCUS will • Restructure and optimize breeding pipelines to align to the prioritized set of product profiles while best leveraging common trait requirements and resources. • Implement product profiles as the guiding force providing direction to all breeding decisions within CGIAR-NARES-SME networks.
Geographic scope: (Global/Region/Country)	High level prioritization among crops and target regions will focus on low and lower-middle income countries. More specific research question will be assessed for breeding pipelines relevant to regions with highest poverty incidence, in particular Sub-Saharan Africa and South Asia, and where few alternative suppliers among well-developed NARES and the private breeding sector exist.

The Science:

Realistic assessments of breeding ambitions are key to rationalizing CGIAR breeding investments. The Initiative ensures CGIAR-NARES-SME breeding teams commit to developing distinct sets of product profiles within a defined time frame and at a given investment. In interaction with MIPP, ReFOCUS will address the following research questions:

Research / Translation / Restructure questions	**Approach**	**Outputs**
Starting with high priority needs and drivers of variety adoption, as identified by MIPP, what product profiles can realistically be developed through breeding with a pronounced improvement in performance? Does evidence for genetic variance exist? What traits can adequately be improved through elite-by-elite crosses (to be addressed through WP5)? What traits are unique and need to be introgressed from distinct donor lines (to be addressed through WP4)? Do the proposed product profiles and market segments adequately consider genotype-by-environment interactions?	Insights from the scientific literature and expert opinions will be complemented with quantitative genetics analysis of: • Genetic variance amongst elite germplasm. • Trait heritability and ability to screen. • Genetic correlations between traits. • Complexity of inheritance (mendelian, oligogenic, or polygenic). • Likelihood of finding suitable sources of genetic variance if not currently available in elite germplasm. • Genotype-by-environment analysis of historical or pilot testing data.	A portfolio of distinct, achievable product profiles - each a unique combination of productivity, adaptation, resilience, quality, processing and end-use traits – that: (i) the CGIAR-NARES-SME breeding teams commit to develop within a certain time frame, and (ii) MIPP can use to develop the associated investment case. A strategic approach for applying population improvement, trait discovery and/or trait deployment to each trait required by farmers and consumers.
How to arrive at adequate genetic gains for highest value traits, while not compromising on other traits crucial for adoption?	For each trait in the target product profile, determine heritability, genetic variance and genetic correlations. Integrate this with MIPP data regarding trait importance and impact.	Selection indices for parent and variety selection that are aligned with product profiles and drivers of impact.

How should breeding pipelines most strategically target each product profile and with what level of investment given, (i) ROI of the breeding investment, and (ii) opportunities for different breeding pipelines to capitalize on each other?	Conduct analysis that considers: (i) investment cases provided by MIPP, (ii) the similarities / differences between product profiles, germplasm used, and underlying quantitative genetics insights, (iii) available budgets for crop-by-region combinations, and (iv) costs of breeding operations. Pipelines may differ significantly, use unrelated germplasm and test for totally different traits and/or in different environments. Or they are partially related for germplasm, traits and/or testing environments. As a result, what focus should each breeding pipeline have, given: Tier 1: Are they independent population improvement cases? Tier 2: Can they be selected within germplasm segregating early stage? Tier 3: Can they be modified through trait introgression? Tier 4: Can they be selected during variety identification?	Breeding pipelines remapped to prioritized and distinct product profiles. Strategically structured and oriented crop breeding pipelines that focus the right levels of breeding efforts and resources on the portfolio of prioritized product profiles for maximum impact.

The theory of change

The purpose of ReFOCUS is to achieve greater focus of CGIAR breeding by working with MIPP to better define product profiles aligned to distinct market segments and target environments; and rationalize and align CGIAR breeding pipeline structures and investments – individually and combined as a portfolio --for greatest and most probable contributions to the five CGIAR impact goals.

The demand for greater focus and clearer prioritization comes from funders and national governments investing public or philanthropic funds into breeding, and from research leaders, breeders and seed companies wanting to invest scarce resources to achieve maximum impact. The CGIAR currently has a portfolio including over 135 product profiles across 24 crops. Breeding pipelines pursue traits related to greater productivity, resilience (to pests and diseases, weather variability and climate change), biofortification (for pro-vitamin A, zinc and iron), reduced greenhouse gas emission, labor-saving or distinct end uses.

Working closely with MIPP and drawing N4ETTS tools and services, ReFOCUS will (i) assess realistic breeding ambitions and associated investments to help define the portfolio of achievable product profiles that the CGIAR-NARES-SME breeding teams commit to develop within a certain time frame, (ii) structure breeding pipelines so that each are aligned with a defined product profile(s), market segment and targeted impact(s).

The key 2024 Outcome - CGIAR-NARES breeding pipelines oriented towards specific market segments, enabling greater focus on farmers' needs, drivers of adoption, and impact - is anticipated to be achieved through four interlinked pathways:

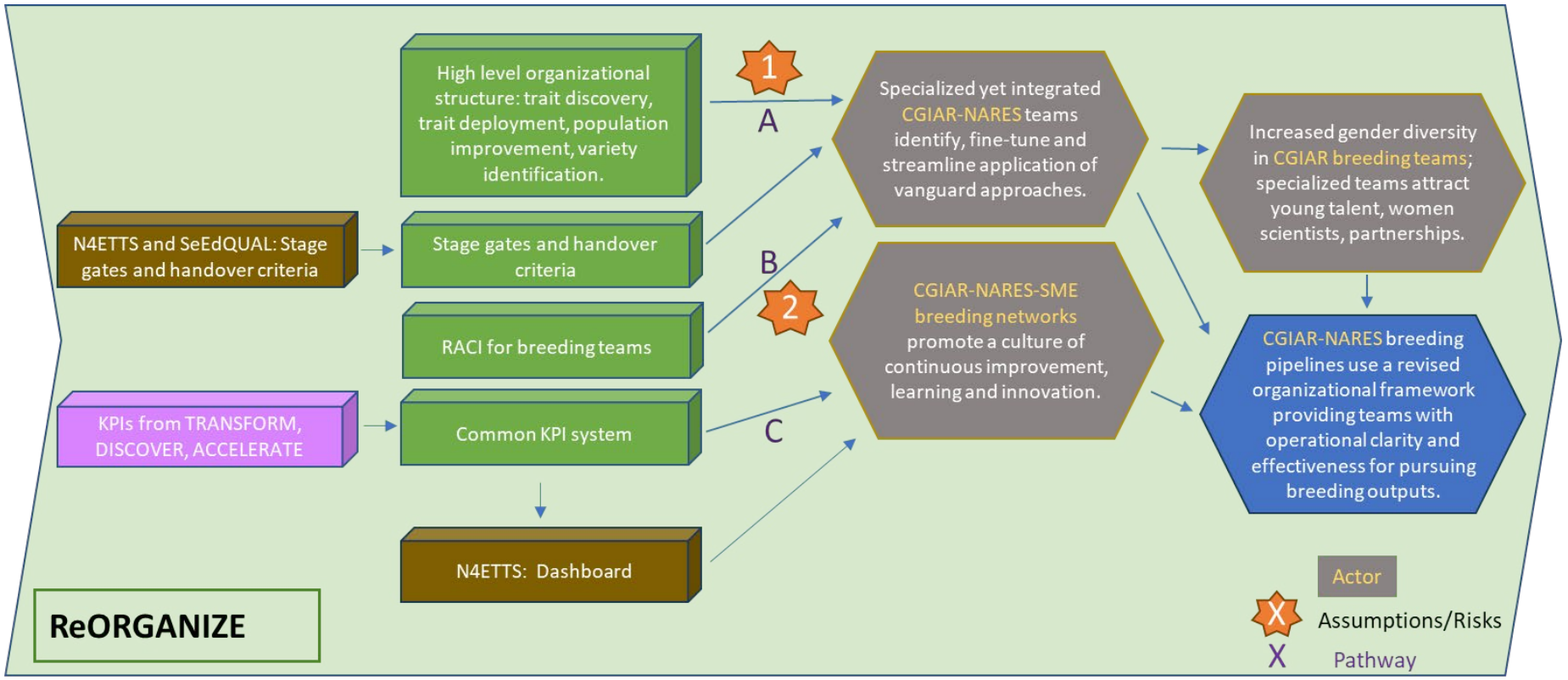
A. **Orientation towards greater adoption:** By CGIAR and NARES breeders working with social scientists (MIPP) and the seed sector (SeEdQUAL) in revising product profiles aligned to market demands, impact opportunities and drivers of adoption, product profiles will become the driving force for all breeding decisions within CGIAR-NARES-SME breeding networks. They determine the traits evaluated and used at each stage of selection, and the relative emphasis given between traits, leading to varieties that will more likely be adopted.
B. **Systematizing client-led validation:** By linking in with SeEdQUAL for client-feedback during on-farm trialing and scale-out, product profiles can be purposefully adjusted and selection emphases shifted. Client-led validation will become a systematized component of the breeding process, and help to evolve the portfolio of targeted product profiles.
C. **Transparency driving breeding investments:** By linking breeding investments and distinct target markets to most likely development impacts on MIPP's Investor Dashboard, transparency is being created that will allow investors, national governments, and implementers to confidently allocate resources to distinct pipeline investment cases.
D. **A system change for targeting:** By NARES and SMEs actively participating in the product profile definition, knowledge for defining and prioritizing product profiles will flow to the NARES and SMEs; they will increase the adoption of these concepts in their own breeding programs.

Key assumptions and risks include:

1	MIPP and ReFOCUS are able to systematically evolve datasets and combine expertise to arrive at an improved definition of product profiles.	Time taken for creating large amount of data paralyzes the process of revising product profiles so they can be used for breeding.
2	Breeders are able to translate product profiles into effective breeding approaches.	Breeders keep pursuing their own views of breeding priorities.

ReFOCUS will co-develop Innovation Packages for all four Pathways with MIPP's Institutional Innovation and G×I Learning Alliance (also including PHRRFLS and SeEdQUAL) (2 core innovations).

TOC *diagram* for ReORGANIZE



3.2.2.2 ReORGANIZE breeding teams to drive efficiency gains

Component	Text
WP2 title	**ReORGANIZE breeding teams to drive efficiency gains**
WP main focus and prioritization	Modern breeding organizations drive efficiency gain, opportunity identification, and operational effectiveness through the coordinated engagement of subject matter specialists and processes. Capitalizing on the change to One CGIAR, this WP realigns breeding activities and teams along agile "form follows function" lines (trait discovery, trait deployment, population improvement, and variety validation), to accelerate genetic gains and consistently pursue the prioritized current and future product profiles. It establishes a common organizational framework, defines appropriate stage gates, cross-cutting and commodity/stage specific KPIs and handover criteria, including to SeEdQUAL. It documents procedures and standards and, assesses and learns from efficiency gains.
Geographic scope: (Global/Region/ Country)	Global, encompassing all CGIAR native breeding activities.

The Science:

Specific innovations will drive improved organizational effectiveness in breeding. These include; streamlining and clarifying breeding organizations to facilitate optimal deployment of skills and scientific interventions; and enhancement of a shared understanding of well-defined roles, responsibilities and accountabilities within and across differing breeding stages providing a backbone for effective personnel management, communication and MELIA implementation.

Research/ Translation/ Restructure questions	Scientific Methods	Key Outputs
What is the optimal CGIAR-NARES operational breeding structure needed to effectively and efficiently deliver, modern, market needs responsive- genetic gains in farmers' fields?	Define the key organizational factors (e.g., team specialization, primary outputs, needed geographical consolidation/spread, any pipeline segregation requirements) that can be used to inform re-structuring to drive improved operational effectiveness and efficiency. Building upon the current analysis guided by EiB (where trait discovery and deployment, core population improvement and variety definition segments are identified), complete the mapping of current structures, processes and teams within commodity and regionally organized groups of the CG-NARES-SME networks. Define duplications, primary outputs of current processes within and across teams, key actor strengths and scaling opportunities. Identify cross-cutting and common organizational themes and conceptual packages which segment and sub-divide breeding into smaller, output and intermediate outcome-oriented inter-linked groups and segments.	High-level organizational structure defined, documented and implemented, demarking key processes, teams (and therein roles, responsibilities, and accountabilities) and outputs of each breeding segment.
Across breeding pipelines, how are standardized and harmonized stage gates best defined for primary output definition and handover points? How are internal	Explore and define the minimum number of critical decision points within breeding segments. Describe the decision to be made, the minimum data and knowledge needed to make an informed decision and the constituency of critical stakeholders who should be consulted,	Identification, definition, documentation and implementation of common stage gates and commodity/pipeline-specific stage gates spanning the whole breeding pipeline and sub-pipeline segments.

segment stage gates defined and implemented?	informed, and actively engaged in the decision-making process.	
How are team organizational "Responsible, Accountable, Consulted, Informed" (RACI) assignments best developed, described, documented, and communicated within breeding segments to facilitate alignment to breeding excellence?	Explore what current tools exist within the breeding networks to provide RACI definition within the different teams of the network. Document the differing definitions and implementations of RACI structures within existing networks. Explore optimal processes and procedures to drive effective breeding RACI implementation.	A RACI framework clearly defined and implemented across and within breeding pipelines improving the communication of, understanding of, equity of and buy-in for specific roles and expectations of teams and individuals within breeding segments.
What are the critical KPIs required for decision making, M&E of breeding pipeline and breeding segment effectiveness, and M&E of team and individual operational engagement and performance?	Work with key funders, breeding managers, scientific stakeholders, clients, knowledge and data managers and personnel resource colleagues to define KPI types, outline critical KPIs, and specific KPI requirements for monitoring and evaluating breeding operational performance.	Definition and deployment within the N4ETTS dashboard (WP3) of lean and informative breeding performance-oriented KPI systems within and across segmented breeding activities.

The theory of change:

The purpose of ReORGANIZE is to realign breeding activities and teams into more effective, efficient, and agile segments with clearer definition and visibility of roles, responsibilities, accountability, and contributions. ReORGANIZE aims to foster greater alignment towards, and co-ownership of breeding outcomes.

The demand for CGIAR-NARES-SME breeding team reorganization has been recognized through BPAT assessments, EiB-level interactions and breeding program self-assessments. These reviews have identified some of the challenges and strengths of current structures and opportunities of reorganization.
Building upon the reviews, and considering good practices observed in public and private sector organizations, **ReORGANIZE** will develop and drive implementation of a common organizational framework together with enabling tools and resources. ReORGANIZE will draw on the insights of CGIAR, NARES and SME process leaders and the experiences from the multinational breeding sector which has undergone similar transformations, to ensure the delivery of pragmatic and agile approaches. Key innovation actors include N4ETTS, Genebanks, and SeEdQUAL for increasingly streamlined work processes between GI Initiatives, and the Gender Platform for implementing appropriate gender inclusive/transformative measures. Participating NARES may choose to deploy approaches across further segments of their operations.

The key 2024 Outcome – CGIAR-NARES breeding pipelines use a revised organizational framework providing teams with operational clarity and effectiveness for pursuing breeding outputs – is anticipated to be achieved through three interlinked pathways:

A. **Outcome-oriented reorganization:** Through understanding the necessary flows of information, knowledge, skills and germplasm within breeding networks, revised structures will be defined and implemented. The definition of stage gates and associated key information requirements will facilitate stop/go decisions between pipelines segments. As a result, teams will become focused on the overall goal, and improve the delivery of demand-based in-scope outputs.
B. **Motivated teams:** By clearly defining roles, responsibilities and accountability of teams and their members, the wider range of disciplines, functional teams and talents are being

recognized for their contribution to the breeding success. This will motivate teams to excel and seek partnerships for vanguard approaches. Women and young scientists will find specialized teams and more transparent recognition for contribution provide more expansive professional opportunities, increasing diversity and innovation.

C. **Metrics-driven learning:** Definition and use of a minimum set of outcome-relevant, informative, readily available KPIs will allow monitoring, decision-making and evaluation to be conducted in a transparent and agile manner. Individuals and teams will seek to optimize approaches to achieve the desirable outcomes. Breeding programs will become more responsive to overall goals and new challenges, and establish a culture of continuous improvement, learning and innovation.

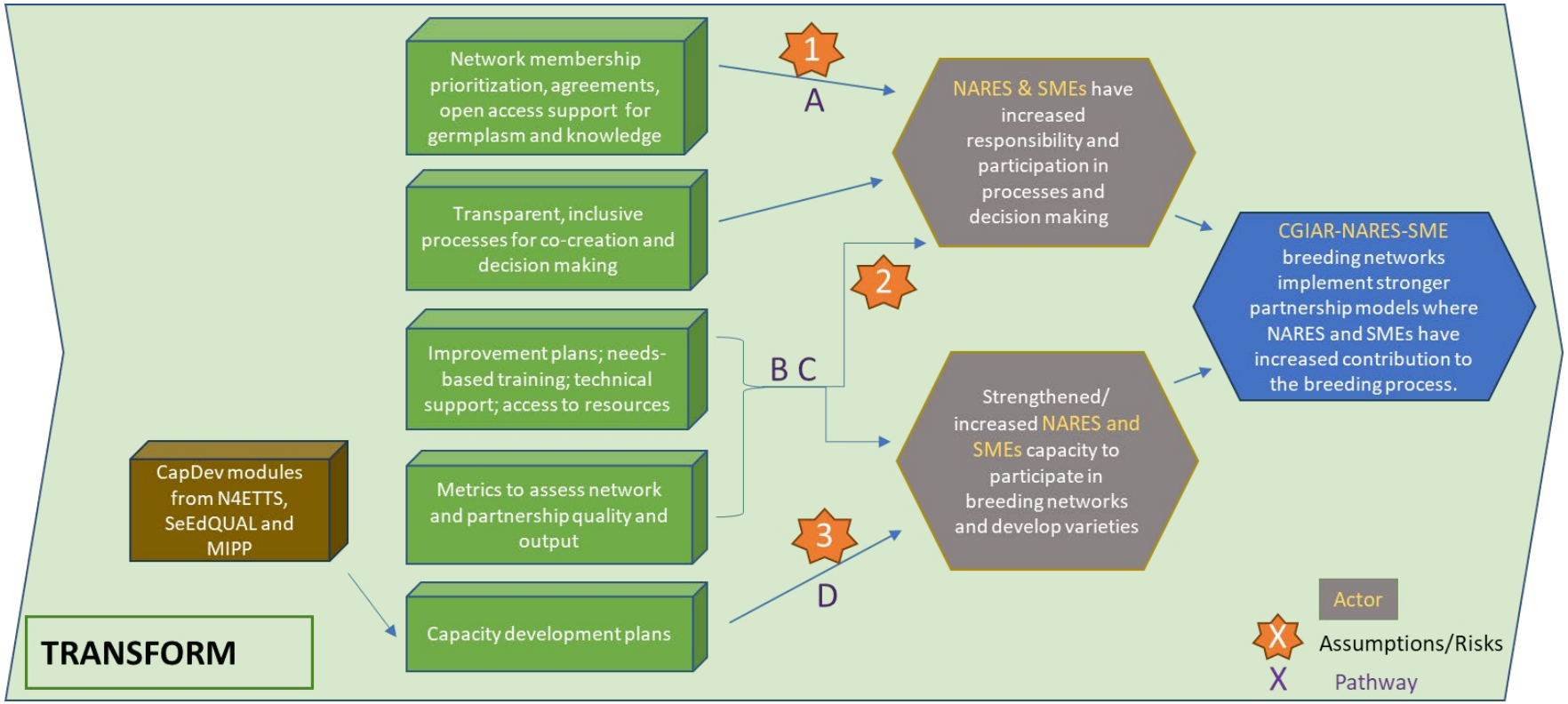
The combined outcomes will transform CGIAR-NARES-SME breeding networks into modern, more efficient and responsive breeding engines which foster inclusive and equitable contributions by staff from all disciplines, levels and gender.

Key assumptions and risks include:

1	The benefit of breeding program segmentation and role definitions are clearly articulated and understood.	Staff are resistant to introducing changes to structure and defining organizational roles, de-railing the improvement process.
2	Stage Gates and KPIs provide clarity to intermediary and end-stage output assessments and are embraced by breeding pipelines as an invaluable information gathering and decision-making resource.	Stage Gates and/or KPIs are poorly defined rendering their use suboptimal or harmful.

ReORGANIZE will co-develop Innovation Packages for all three Pathways with N4ETTS WP3 (Performance Management of Consistent Connected Operations) (1 core innovation).

***TOC* diagram for TRANSFORM**



3.2.2.3 TRANSFORM towards inclusive, impactful CGIAR-NARES-SME breeding networks

WP 3 title	TRANSFORM towards inclusive, impactful CGIAR-NARES-SME breeding networks
Work Package main focus and prioritization	TRANSFORM evolves current CGIAR-NARES-SME breeding networks to fully capitalize on the human and operational capacity that exists across institutions, increase ownership and empower local partners. It: 1. Implements approaches for NARES and SMEs to guide decision-making and assume greater responsibilities in the implementation of collaborative breeding approaches, aligned with their evolving strength and mandate. 2. Provides partners with crucial skills, tools and resources to execute their roles and responsibilities. 3. Designs approaches to share breeding outputs and know-how. 4. Develops metrics to assess partnerships strength and network performance and scales learnings across all CGIAR-NARES-SME breeding networks.
Work Package geographic scope (Global/Region/ Country)	Sub Saharan Africa and South Asia

The Science:

Integrated CGIAR-NARES-SME breeding networks are key to delivering the goals of ABI: increased genetic gain realized in farmer's fields and faster variety turnover in low and lower-middle income countries. The diversity of crops and target markets will require full engagement of multiple partners aligned around a common vision for success. TRANSFORM will strengthen breeding networks by addressing the following research questions:

Research / Translation/ Restructure questions	Approach	Outputs
With over 500 NARES and SME crop breeding programs in Africa and South Asia, how can we prioritize partners for each crop breeding network to ensure efforts reach critical mass in priority countries, while creating benefits to the wider breeding community?	Jointly analyze current networks for best practice approaches; utilize insights from MIPP, One CGIAR partnerships, and regional organizations.	Prioritization criteria for countries, NARES and private sector partners based on factors including crop importance to poverty, gender equity and climate resilience; capacity and willingness of partners to contribute; existing centers of excellence. Network membership agreements outlining expectations, accountabilities, rules and approaches for participation. Open access support for other institutions to access network germplasm and knowledge.
How can we better leverage the capacity and strengths of each NARES and SME network member to accelerate breeding progress?	Jointly review and systematically augment roles and responsibilities of NARES and SMEs in existing CGIAR-NARES-SME crop breeding networks by 2024, aligned with partners' sustainable change ambitions.	Network members assume defined and agreed roles and responsibilities based on their comparative advantage and market opportunity. TRANSFORM guides and enables NARES-SME members to implement modern breeding approaches, including: • Execute early-stage evaluation and use validated genomic selection approaches. • More effectively utilize data, germplasm, tools and services to meet local market requirements. • Expand on-farm evaluation. • Take responsibility for distinct network breeding pipelines.
	Establish streamlined processes to ensure network priorities are jointly developed,	NARES and SMEs participate in key decision-making processes, in particular: product profile definition and their annual review; product advancement decisions with a view to taking full

	research agenda is co-created and decision making is inclusive and transparent.	ownership of late stage/local advancements; planning and review of network activities.
How can NARES be empowered to assume greater responsibility for network goals and assume some of the roles CGIAR currently plays?	Objectively and constructively assess partners' current states, using and evolving tools implemented by BPAT and EiB, to develop customized improvement and capacity development plans aligned to network roles and partners' sustainable change ambitions.	Breeding Program Improvement Plans: Partner assessments and characterization to identify current strengths, change ambitions and metrics, and capacity development needs. Capacity development consisting of needs-based training and technical support, also drawing on MIPP, SeEdQUAL, N4ETTS and external expertise.
	Equitable allocation of network budget, aligned with roles and responsibilities.	Up to 30% of crop breeding budgets allocated to NARES and SMEs to effectively execute their roles in CGIAR-NARES-SME breeding networks.
How do we quantitatively measure the performances of CGIAR-NARES/SME breeding networks and partnerships?	Develop metrics to assess crop breeding networks for partnership quality and germplasm output.	Insights and learnings are scaled across CGIAR-NARES-SME crop breeding networks.

The theory of change

The purpose of TRANSFORM is to implement more inclusive and effective partnership models for CGIAR-NARES-SME breeding networks, strengthen local partners' role in pursing jointly prioritized product profiles, and create ownership crucial for faster deployment.

The demand for greater co-ownership and collaboration comes from policy makers and funders seeking "effective public, public-private and civil society partnerships that build on the experiences of, and optimize resourcing strategies among all partners" (SDG 17.17). In addition, NARES, SMEs and ARI's seek greater clarity and recognition for their roles and responsibilities in collaborative breeding networks.

TRANSFORM will work closely with ABI Work Packages ReORGANIZE and ACCELERATE to ensure defined stage-gated, handover processes and modern breeding approaches are scaled throughout CGIAR-NARES-SME breeding networks. TRANSFORM will also link with N4ETTS, MIPP and SeEDQUAL to ensure local partners have access to centralized breeding services and can effectively assume greater responsibilities in priority setting and variety deployment.

The key 2024 Outcome - CGIAR-NARES-SME breeding networks implement stronger partnership models where NARES and SMEs have increased contribution to the breeding process - is anticipated to be achieved through four interlinked pathways:

A. **Terms to enhance collaboration and measure network performance:** By developing network membership agreements, partners clearly understand benefits and commitments of participating in CGIAR-NARES-SME breeding networks, including how countries and institutions beyond those able to participate as members will be able to utilize distinct germplasm outputs and knowledge. Establishing metrics to routinely assess the effectiveness of breeding networks will establish a culture of continuous improvement amongst partners.
B. **Developing effective and participatory collaborative breeding models:** By clearly defining roles and responsibilities of each network member based on breeding program assessments, market opportunity and comparative advantage, members will have clearer focus and accountability. By actively generating data and participating in key decision-making

processes, partners will have a greater sense of ownership and commitment to ensuring networks are successful in identifying and deploying network varieties quickly and at scale.

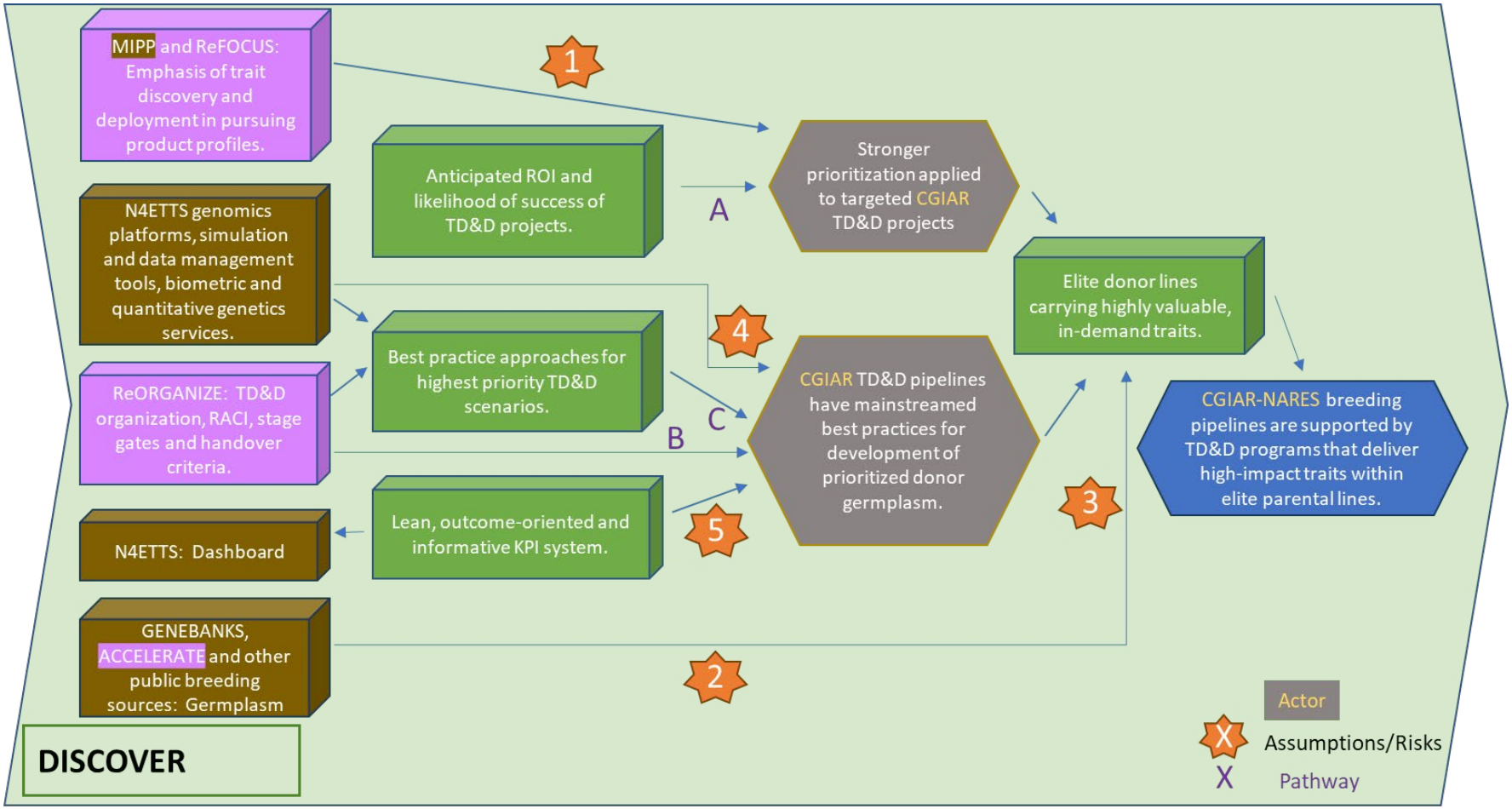
C. **Effective resource allocation:** By promoting more effective resource allocation amongst network members aligned to their roles and responsibilities, partners will be better able to execute their roles to the necessary standard to enable accurate, timely, data-driven decision making.
D. **Targeted capacity development:** By agreeing on improvement plans, providing technical support, needs-based training and resources, NARES and SME partners are able to assume greater responsibility and accountability for their roles in CGIAR-NARES-SME breeding networks including assuming more responsibility for germplasm development. Partners will realize greater genetic gain because they are able to capitalize on skills and contributions by other network members in addition to tools and services from N4ETTS.

Key assumptions and risks include:

1	Learning from good examples in current breeding networks, it will be possible to standardize approaches and develop simple processes that foster collaboration and inclusion.	CGIAR, NARES and SME breeders stay focused on their individual programs and do not see the benefit of collaboration and inclusive decision-making.
2	National strategic plans align with the ABI vision for more effective CGIAR-NARES-SME networks	NARES and SMEs pursue alternate strategies such as investing in in-house service provision or duplicating efforts being made in breeding networks.
3	One CGIAR Initiatives are able to provide the necessary Capacity development support	Lack of staff, training materials or other extenuating factors (e.g., COVID pandemic) prevent effective capacity development with partners and networks are unable to evolve

TRANSFORM will co-develop Innovation Packages related to Pathways A, together with SeEdQUAL, and for B, C and D with N4ETTS (WP5-IDARE) (2 core innovations).

TOC diagram for DISCOVER



3.2.2.4 DISCOVER: Trait Discovery and Deployment

WP4 title	DISCOVER: Trait Discovery and Deployment
WP main focus and prioritization	Accessible and relevant trait variation is fundamental to the delivery of genetic gain through core breeding pipelines. Native TD&D supply demanded and tractable genetic variance in genetically elite backgrounds to the variety development pipeline to meet current and prospective breeding targets. Examples include resistance to devastating pests and diseases, abiotic stress tolerance e.g., submergence tolerance, nutritional or quality traits. DISCOVER will drive, right-size and synergize TD&D efforts, focusing on identifying, understanding, optimizing, and delivering demanded trait variation and associated knowledge packages to the core breeding pipelines in a transparent and prioritized manner.
Geographic scope: (Global/Region/Country)	Global, drawing in on the global genetic diversity.

The Science:

Research/ Translation/ Restructure questions	Approach	Key Outputs
For defined trait complexities and necessities, how do we right-size investment in TD&D within and across the different crop species considering program size, market impact, risk, and potential return on investment?	A data-driven framework will be established to assess the potential return of investment (ROI) of ongoing and newly demanded TD&D discovery strategies considering: • Urgency of need and projected future value/demand for the trait, as assessed by MIPP and needs expressed by core breeding pipelines (population improvement). • Trait sources, complexity and phenotyping ease. • Cost estimates and likelihood of success based on a combination of simulations, principles of quantitative and population genetics, current status of knowledge and the need to invest in discovery research. Defining no-go/go decision points for further investments between discovery within improved, exotic or unimproved background, development, validation and scaling.	Investment case standardization, transparency, procedures and tool for TD&D. Documentation of the anticipated ROI and likelihood of success of all existing activities. All TD&D projects prioritized according to anticipated ROI and likelihood of success. Discontinuation of activities with low ROI and likeliness of success, and refocusing on those with higher and more secure ROI.
For defined trait complexities, potential donor sources, and potential elite parent sources, how do we identify, optimize and effectively implement approaches to TD&D within the different crop species considering inbreeding, outcrossing and vegetatively propagated systems and biological breeding barriers? Addressing sub-questions such as: • How best to identify trait variation.	Reviews of current practices, and potential enabling tools and practices. Exploring opportunities to adopt new methods and findings generated advanced research institutes or the private sector. Discovery research simulations and deployment practice simulations incorporating quantitative and population genetics principles conducted to evaluate strategies and identify best practice opportunities for TD&D optimizing genetic gain for target traits per unit of investment. Strategic consideration taken of priority crops, trait complexity, trait genetic control, trait donor sources, breeding systems, available and potential enabling tools,	Best practice documentation for the highest priority TD&D scenarios developed. TD&D teams are implementing best practices in projects enhancing the identification and repackaging of novel, demanded traits into new elite-based donors and correcting specific deficiencies in variety candidates. Sub-optimal approaches across crops identified, and associated activities optimized or discontinued.

• How best to validate trait variation. • How best to repackage trait variation in deployment. • How best to incorporate learning across crops.	timeframes and resource use per unit gain for delivery of outputs.	A culture of continuous improvement culture mainstreamed and supported in TD&D programs
What are the most efficient and effective KPIs to monitor and analyze progress, and encourage desired changes?	Work with key scientific stakeholders, clients, knowledge and data managers and human resources to outline desired KPIs and test capacity to implement, scope to promote desired cultural and process changes and effectiveness and ease to monitor TD&D activities.	Lean, outcome-oriented and informative KPI system supporting and driving implementation of best practices in TD&D activities.

The theory of change:

The purpose of DISCOVER is to increase the speed and accuracy with which novel and high-value traits can be incorporated into CGIAR and NARES breeding pipelines that mostly work with elite and adapted germplasm. This work is fundamental for providing functional variation for novel traits and delivering greater genetic gains through the breeding process.

The demand for elite donor lines carrying high-value traits comes from social scientists, portfolio managers and breeders as they co-define the portfolio of prioritized product profiles (in MIPP and ReFOCUS) and recognize that key traits are missing within the elite breeding populations. In collaboration with N4ETTS, TD&D teams need to be able to acquire and repackage such traits with greater focus, speed and effectiveness into elite parental germplasm used by CGIAR and NARES breeders, including when sourced from landraces. The principal output from NOVEL, elite donor lines carrying high-value traits, is a primary input to ACCELERATE.

The key 2024 Outcome—CGIAR-NARES breeding pipelines are supported by TD&D programs that deliver high-impact traits within elite parental lines—is anticipated to be achieved through three interlinked pathways:

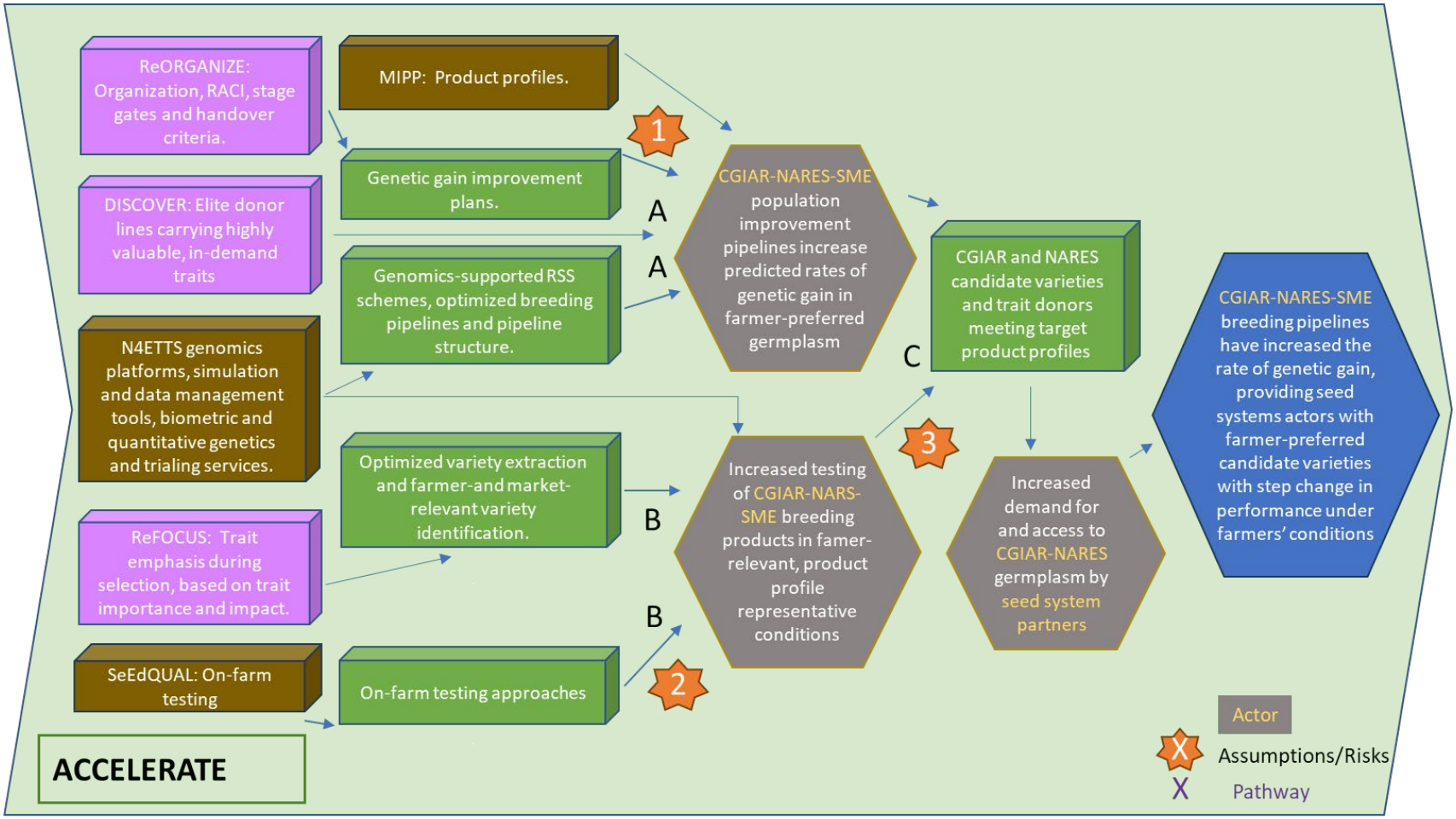
A. **Through the prioritization pathway**: By co-creating and applying a common framework for defining the highest priority TD&D targets, aligned to the portfolio of prioritized product profiles, and reassessing these targets over time, TD&D teams share a common vision of success across crops and traits, and are able to aggregate resources and skills to ensure product delivery. As a result, TD&D teams will increase their success in making relevant contributions to the breeding process and future varieties.
B. **Through the research, translation and implementation pathway**: The mainstreaming of situation-appropriate TD&D best practices, supported by training, active communication and knowledge dissemination, will reduce time-to-success and increase the uptake of high-value trait donors by CGIAR and NARES breeders.
C. **Through the change-promoting monitoring pathway**: The active use of outcome-based KPIs within TD&D pipelines will promote a culture of continuous improvement within teams, driving the implementation of agile and effective TD&D activities.

Key assumptions and risks of DISCOVER include:

1	MIPP and ReFOCUS are able to identify targets where TD&D will be able to move suitable genetic variation into elite breeding populations.	TD&D targets are poorly defined or represent challenges with technical solutions outside the scope of breeding.
2	Sources of novel genetic variation are identifiable in CGIAR and non-CGIAR breeding pipelines, or from genebanks.	Novel sources of genetic variation are unavailable or intractable.
3	ACCELERATE clearly articulates the specifications for trait donors.	Elite trait donors do not meet the requirements of ACCELERATE and are not used by breeders.
4	Appropriate innovations, tools and services are available through N4ETTS to deliver on TD&D portfolio.	Situation-appropriate innovations and technologies are unavailable, limiting and delaying the delivery of the TD&D portfolio.
5	Definition and use of outcome-oriented KPIs drives desired culture change.	KPIs are ill-conceived and do not drive the needed changes in organizational culture.

DISCOVER will co-develop Innovation Packages for Pathways A (with MIPP) and B (with N4ETTS) and work with ReORGANIZE for Pathway C (2 core innovations).

TOC diagram for ACCELERATE



3.2.2.5 ACCELERATE population improvement and variety identification

Component	Text
WP5 title	ACCELERATE population improvement and variety identification
WP main focus and prioritization	ACCELERATE will execute and optimize CGIAR-NARES-SME breeding pipelines, increasing realized rates of genetic gain oriented towards the prioritized set of crops and product profiles established in collaboration with MIPP. Leveraging tools and services from N4ETTS, and elite parental lines carrying high-value traits from ABI-DISCOVER, it will: 1. Accelerate breeding cycles within elite populations used for distinct pipelines 2. Implement best-practice phenotyping, molecular and data management approaches, 3. Shift trialing to better reproduce farmers' environments and management practices, and 4. Deliver more productive, nutritive, climate-resilient varieties, including those offering new marketing and income opportunities to farmers, women and marginalized groups, to SeEdQUAL and the relevant seed system.
Geographic scope: (Global/Region/ Country)	Global. The primary focus is on Sub-Saharan Africa and South Asia. Breeding activities will at times be required in the center of origin for a particular species, or for logistical reasons in other locations, which may be outside of these regions.

The Science:

Accelerating genetic gains and making more precise variety selections require interdisciplinary teams of scientists to address the following research questions in the context of complex genetics, target environments, and breeding challenges.

Research / Translation / Restructure questions	**Approach**	**Key Outputs**
How do we sequence breeding scheme optimization, including use of N4ETTS tools and services, given crop-specific biological, logistical and budget constraints?	Assess ambitions for increasing rates of genetic gain for: dependencies on new capabilities, likelihood of success, cost, difficulty and time to implement.	Crop-specific prioritized plans for increasing rates of genetic gain.
How do we maximize genetic gain per year whilst maintaining sufficient genetic variance?	Trade-off analyses between accuracy, cycle time, selection intensity and maintenance of genetic diversity using AlphaSimR simulation software. Assess genomic selection (GS) prediction models for greater accuracy. Pilot higher risk schemes and assess improvements before scaling across entire pipeline. Explore further opportunities for speeding line development (e.g., contra-cycle nurseries or manipulating phenology triggers).	Crop- and pipeline-specific rapid-cycle recurrent selection schemes sustaining higher genetic gains in the short, medium and long-term. More accurate GS supporting faster breeding cycles and more accurate selection of crossing parents.
How do we balance resources between population improvement and variety identification (i.e. when and how to move from testing heterogeneous selections to begin developing homogeneous candidates)?	AlphaSimR simulations to optimize (i) number of homogeneous selections to be taken from high-performing heterogeneous candidate used to drive faster cycle times; (ii) genomic selection vs phenotypic selection of and between candidates extracted from a common heterogeneous line; (iii) choice and number of early- and late-stage testers for hybrid crops. Pilot higher risk schemes and assess improvements before scaling across entire pipeline.	Optimized breeding pipelines, achieving higher rates of genetic gain.
How do we leverage breeding investments	Quantify the decline in estimated breeding value between breeding pipelines; run simulations to	A set of related breeding pipelines that strategically

across product profiles and target markets?	develop strategies for sharing germplasm across breeding pipelines. For hybrid crops, apply genetic distance analysis to enforce heterotic groups.	leverage breeding investments and progress.
How to develop robust data to support variety selection aligned with product profiles and farmers' actual growing conditions.	Review product profile traits for opportunities to improve trialing methods, and/or use of technology to increase accuracy, and/or throughput, and/or reduce cost. Determine genetic correlations and GxE from trial data and optimize the combination of selection environments, for each stage of testing, for representing performance in the target population of environments (TPE).	Larger-scale, more accurate and relevant testing approach. Crossing parents and varieties are selected based on data capturing product profile characteristics, the TPE and farmers' conditions.
What is the most effective and efficient way to capture performance of selection candidates' performance under typical farmers' conditions?	Pilot schemes for expanding on-farm trialing in selected crops and countries: Trade off scale of operation, costs, data (qualitative/quantitative), use of new technology (crowd-sourcing), and synergies with scale-out or knowledge partners (extension, schools, NGOs). Capture learnings for scale-out.	On-farm testing approaches that better represent farmers conditions and views.

The theory of change:

The purpose of this Work Packages is **to accelerate genetic gains for varieties that meet farmers' and markets' demands** and make significant contributions to impact targets.

The demand for improved varieties comes from: farmers seeking to improve household food security and incomes, or solutions to changing climates, pests and diseases; processors seeking distinct end-use characteristics; country governments and civil society pursuing economic development, reduced malnutrition, and stability in agricultural production.

Working closely with N4ETTS, **ACCELERATE** will work with CGIAR and local breeding teams to redesign breeding pipelines in accordance with current best-practices and principles of quantitative genetics, and align variety selection with product profile characteristics. The principal outputs of ACCELERATE are market-demanded candidate varieties and modernized breeding programs that deliver greater rates of genetic gain per dollar invested.

The key 2024 Outcome—CGIAR-NARES-SME 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—is anticipated to be achieved through three interlinked pathways:

A. **Accelerating breeding progress:** By capitalizing on the improved organization of breeding teams, including between the CGIAR, NARES and SMEs; by using novel traits provided by DISCOVERY in elite parental lines; by using genomics platforms, simulation and data management tools, and quantitative genetic services from N4ETTS; CGIAR and NARES breeding programs will be able to accelerate recurrent-selection cycles in population improvement schemes. They will be able to assemble the traits needed in the desirable product profile faster, and realize greater improvements within a given time period.
B. **Enhanced breeding focus:** By breeding teams structuring testing approaches to accurately capture product profile characteristics and farmer-relevant conditions and focus on distinct target population of environments (TPEs), CGIAR-NARES-SME breeding teams will take a more focused approach to the identification of varieties that fit the needs for targeted and specific market segments, environments and product profiles. This will result in increased rates of genetic gain and varieties that more readily meet farmer and market expectations.

C. **Fostering adoption:** By being able to develop varieties with a step-change in performance and that are selected aligned to farmer and market expectations, by involving seed systems actors and farmers' feedback in variety identification, fewer variety candidates will be selected but they are better performing and better aligned with the drivers of adoption. Further facilitated by SeEdQUAL, seed system actors will be more confident in scaling-up these varieties and making them available to farmers, accelerating variety replacement in farmers' fields.

Key assumptions and risks include:

1	Breeding teams are able to prioritize and focus on those approaches that create the greatest value for accelerating breeding cycles and variety identification.	Breeding teams are overwhelmed by the opportunities to improve genetic gains and try to implement too many, therefore incomplete changes.
2	Testing locations are available that reliably capture product profile characteristics and the TPEs, or are easily adapted.	Testing locations that are able to capture product profile characteristics and the TPEs (including under farmer conditions) are challenging to identify, equip or manage.
3	Breeding teams learn and optimize approaches based on feedback from seed systems actors/SeEdQUAL during scale-out.	Breeding teams do not receive or use feedback from seed systems actors and farmers.

ACCELERATE will co-develop Innovation Packages for Pathways A and B together with N4ETTS's (Strategic Modernization), and for Pathway C with SeEdQUAL (2 core innovations).

4. Innovation Packages and Scaling Readiness Plan

4.1 Innovation Packages and Scaling Readiness Plan

The Initiative will collaborate with four other Initiatives to co-develop Innovation Packages around nine Core Innovations, as described within the Work Package-specific Theories of Change. They include Core innovations 1 and 2 within ReFOCUS (with MIPP, SeEdQUAL, PHRRFLS), Core Innovation 3 within ReORGANIZE (with N4ETTS), Core Innovations 4 and 5 within TRANSFROM (with SeEdQUAL and N4ETTS), Core Innovation 6 and 7 within DISCOVER (with MIPP and N4ETTS) and Core Innovation 8 and 9 within ACCELERATE (with N4ETTS and SeEdQUAL). The budget includes a staff position to oversee the Innovation Packages and Scaling Readiness Plan implementation which represents 26–50% of the total Initiative innovation portfolio. Capacity development will be extended to Work Package leaders and other relevant staff. Through the plan and associated approaches, ABI is expecting to identify bottlenecks and developing strategies for greater adoption during scaling of the Core Innovations. MELIA collected indicators of outputs and outcomes, and associated learnings will inform the plan for necessary adaptation during implementation. The success of the overall Initiative relies on scaling Core Innovations 1, 3, 4, 6, 8 early in the Initiative which therefore should be prioritized for scaling backstopping in the First Wave, starting Q1-2022. The other four Core Innovations are to be included in the Second Wave, starting Q4-2022. The Initiative allocated US$ 1,071,853 to implement the Innovation Packages and Scaling Readiness plan (2022: US$ 344,331; 2023: US$ 357,115; 2024: US$ 370,406). Dedicated activities, deliverables, indicators and line-items are included in the Management Plan, MELIA and Budget Sections.

5. Impact statements

5.1 Nutrition, health & food security

Challenges and prioritization

Distinct ABI breeding pipelines contribute to reducing hunger and enabling affordable, healthy diets for millions of people who do not have adequate access to safe and nutritious food, by:

1. Increasing the productivity of major food crops, that when adopted, through market-level effects reduce food prices (Wiebe et al., 2021).
2. Increasing the resilience of crops to weather variability and devastating pests and diseases. Technology adoption increases the food supply for farm families that experience significant production shortfalls and have no alternatives (irrigation, pesticides) (Garrett et al, 2017; Rovere et al., 2014).
3. Increasing the competitiveness of staple crops with higher levels of bioavailable pro-vitamin A, zinc, or iron to encourage large-scale adoption in distinct target countries (Biofortification Priority Index).
4. Mainstreaming Zinc biofortification in dominant staple crops – rice and wheat in particular.
5. Increasing breeding investments in legumes, assuming and looking for evidence from SHiFT that farm adopters will modify crop choices and, through market-level effects, increase the affordability of a healthier food basket.

Research questions

All research questions are relevant to this Impact Area, with two more specific applications:

ReFOCUS, ACCELERATE, DISCOVER: How do we arrive at adequate genetic gains for traits important for biofortification, while not compromising on other traits crucial for adoption?

ReORGANIZE: How can a modified operational breeding structure best assist legumes to capitalize on the breeding approaches developed for larger crops?

Components of Work Packages

ReFOCUS: CGIAR-NARES-SME breeding pipelines oriented towards specific market segments, enabling greater focus on farmers' needs, drivers of adoption, and impact, including for crops and market segments where food-insecure farmers most likely benefit from resilience traits, or consumers most likely benefit from biofortification.

DISCOVER: CGIAR-NARES breeding pipelines are supported by TD&D programs that deliver high-impact traits within elite parental lines, as they relate to distinct stress tolerance, pest or disease resistance, and nutritional traits.

ACCELERATE: CGIAR-NARES-SME 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, including more productive, resilient and/or biofortified varieties.

Measuring performance and results

- Number of food insecure and malnourished people within the footprint of supported breeding pipelines.
- Proportion of breeding pipelines realizing a step-change in performance in productivity, resilience, biofortification.

Partners

The key demand for more productive, resilient and biofortified varieties come from countries with low or variable in-country production and high number of food insecure and malnourished people. Partnerships apply as specified in all Work Packages.

Human resources and capacity development of Initiative team

As driven by the organization and implementation of more effective breeding approaches across ABI.

5.2 Poverty reduction, livelihoods & jobs

Challenges and prioritization

The ABI breeding portfolio is directed towards crop-by-region combinations that together encompass > 85% of the poverty-weighted value of crop production in low- and middle-income countries, using estimates made by Wiebe et al. (2021). ABI investments will strongly increase productivity gains realized through breeding under smallholder-relevant conditions. MIPP will create market intelligence to orient breeding pipelines towards product profiles that are demanded by the market and will enhance farmer adoption. Already now, end use traits entail the largest group of traits considered in CGIAR breeding pipelines, next to yield, resilience and production traits. The aim is to direct breeding efforts where there is the greatest projected benefit within the targeted geographies. Technology adoption will raise incomes of farm adopters and contribute to the development of local value chains, creating entrepreneurial and employment opportunities in transport, local and industrial processing, and marketing. Through market-level effects, consumers pay less for food.

Research questions

All research questions are relevant to this Impact Area. Given the diversity of end user demands and agro-ecologies for individual crops, two questions are critical to achieving impact at scale:

ReFOCUS: How should breeding pipelines most strategically target each product profile and with what level of investment given: (i) ROI of the breeding investment, and (ii) that different breeding pipelines may capitalize on each other?

TRANSFORM: How do we better leverage the capacity and strengths of each NARES and SME network member to accelerate breeding progress and achieve impact at scale?

Components of Work Packages

ReFOCUS: CGIAR-NARES breeding pipelines oriented towards specific market segments, enabling greater focus on farmers' needs, drivers of adoption, and impact.

TRANSFORM: CGIAR-NARES-SME breeding networks implement stronger partnership models where NARES and SMEs have increased contribution to the breeding process.

ACCELERATE: CGIAR-NARES-SME 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.

Measuring performance and results

- Number of people below the poverty line of US$1.90 per day (2011 PPP), within the footprint of supported breeding pipelines.
- Proportion of breeding pipelines realizing a step-change in performance in terms of productivity increases under farmers conditions.

Partners

The key demand for more productive, market-demanded varieties come from countries with inadequate in-country production and high number of rural unemployment. Partnerships as specified in all Work Packages apply.

Human resources and capacity development of Initiative team

As driven by the organization and implementation of more effective breeding approaches across ABI.

5.3 Gender equality, youth & social inclusion

Challenges and prioritization

The Initiative identified approaches for contributing to: (i) developing new opportunities for employment or entrepreneurship to women and young adults, (ii) closing the gender gap.

1. When adopted, ABI's core trust – to develop market-demanded varieties – will lead to more, more diverse and better suited products for local value chains, creating new entrepreneurial opportunities and employment, including for women and young adults.
2. Based on MIPP input, ABI will increase breeding efforts for traits and crops most relevant to increasing women income opportunities.
3. Distinct, current breeding pipelines target product profiles that reduce the need for tedious manual labor, often executed by women and children, and improve a women's ability to support herself and her family. These are varieties requiring less time for processing, transplanting, cooking or striga-weeding.
4. The Initiative fosters women's participation and leadership, and the development of young scientists through the design and organization of CGIAR-NARES-SME networks.

Research questions

ReFOCUS: What evidence exists for making progress for labor-saving traits: absence of chalkiness (rice); faster cooking (cassava, beans, cowpea); striga resistance (cowpea, maize, millet, sorghum)?

ReFOCUS: Based on MIPP's assessment of crops and traits most important for women and young adults, how do we most effectively adjust product profiles and breeding approaches?

MIPP, ReFOCUS and SeEdQUAL: What is the feedback of women, young adults and socially disadvantaged groups to new varieties and how should product profiles be adjusted?

ReORGANIZE and TRANSFORM: How do we attract, mentor and career-advance women and young scientists in CGIAR and partner breeding programs to reduce gender gaps?

Components of Work Packages

ReFOCUS, TRANSFORM, DISCOVER, ACCELERATE: CGIAR-NARES breeding pipelines oriented towards specific market segments, enabling greater focus on farmers' needs, drivers of adoption, and impact.

ReORGANIZE: Increased gender diversity in CGIAR breeding teams; specialized teams attract young talent, women scientists, partnerships.

Measuring performance and results

- Proportion of gender-intentional product profiles pursued and associated breeding investments.
- Proportion of women scientists and leaders in ABI networks.

Partners

ABI will work with MIPP, the Gender Platform, and GREAT at Cornell University (https://www.greatagriculture.org/) for implementing and further evolving variety targeting (demand) and development (innovation). Scaling partner SeEdQUAL will be a crucial source for gender-disaggregated feedback from variety users.

Human resources and capacity development of Initiative team

- TRANSFORM will work with the Gender Platform and GREAT to develop a gender-affirmative capacity development and mentoring strategy for CGIAR-NARES-SME network members.
- MIPP will evolve the gender relevance of the ABI breeding portfolio and provide associated capacity development opportunities.

5.4 Climate adaptation & mitigation

Challenges and prioritization

Crop breeding is a highly effective approach to equip millions of small-scale producers to be more resilient to climate shocks, and make climate adaptation solutions available through national innovation systems (Atlin & Cairns, 2017; Challinor et al., 2014; Rovere et al., 2014). A large proportion of CGIAR breeding pipelines and networks pursue breeding objectives to adapt crop varieties to changing season lengths or pest and disease occurrences; or to develop tolerance to drought (beans, cassava, cowpea, maize, millet, potato, rice, sorghum, sweet potato, wheat), heat (beans, chickpea, maize, potato, wheat), submergence (rice) or water logging (maize). In addition, rice varieties with increasing suitability for direct seeding are being developed, to make a substantial contribution to reducing methane emissions (Basavalingaiah et al., 2020; Pathak et al., 2013). In collaboration with MIPP and N4ETTS, ABI will focus stress breeding efforts on product profiles with highest ROI and draw lessons from best practice approaches developed for some crops (Ismail & Mackill, 2013; Prasanna et al., 2021), to accelerate stress breeding in other crops and prioritized breeding pipelines.

Research questions

ReFOCUS: What product profiles can realistically be developed to adapt priority crops to current and future weather variability and climate change, as prioritized by MIPP, either by changing emphasis on maturity groups that fit into future season lengths (by growing degrees), or through the development of drought, heat, waterlogging or submergence tolerance?

ReFOCUS: What product profiles, beyond direct-seeded rice, can realistically be developed to make relevant contributions to the reduction of greenhouse gas emissions?

ReFOCUS, DISCOVER: What are promising candidate genes, beyond submergence tolerance in rice, that could effectively be introgressed from distinct donor lines?

ACCELERATE: How do we develop robust data to support genomic-assisted rapid-cycle recurrent selection and variety selection for relevant climate scenario? To what extent can crop-specific experiences, such as the use of managed abiotic stress environments, be extended to other crops?

Components of Work Packages

DISCOVER: CGIAR-NARES breeding pipelines are supported by TD&D programs that deliver high-impact traits within elite parental lines, including as they relate to maturity changes or stress tolerance.

ACCELERATE CGIAR-NARES-SME 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, including those affected by weather variability and climate change.

Measuring performance and results

- Proportion of climate-relevant product profiles pursued and associated breeding investments.

Partners

The key demand for stress-tolerant crop varieties comes from farmers and countries increasingly affected by climate change. ABI will exchange experiences on validated, mostly crop-specific approaches to abiotic stress breeding. And ABI will work with N4ETTS, advanced research institutes and the multinational breeding sector to adapt, validate and scale most promising approaches in other prioritized crops.

Human resources and capacity development of Initiative team

Building on existing experiences and infrastructure in some crops, capacity for researching and applying stress breeding approaches will be built in other crops where prioritized by product profiles.

5.5 Environmental health & biodiversity

Challenges and prioritization

The initiative supports environmental health and biodiversity in multiple ways.

1. Elevating productivity – a key objective of ABI – results in a net-saving of land (Byerlee et al., 2014), supporting efforts to stay within environmental boundaries.
2. Drawing on the vast genetic diversity in its active breeding germplasm and genebanks, CGIAR breeding networks are uniquely effective in mobilizing rare genetics to develop resistance to new pests and diseases (Garrett et al., 2017), building resilience and reducing pesticide use.
3. Breeding efforts are ongoing to increase water and fertilizer use efficiency for low-input farming systems. ABI will systematically shift variety identification to smallholder-relevant, low-input conditions.
4. Bracharia varieties are being developed to suppress soil nitrification and increase nitrogen use efficiency (Karwat et al., 2017).
5. GI's and ABI's work on a wider range of crops and product profiles are crucial for maintaining the genetic diversity of seeds and cultivated crops. Legumes benefit from ABI extending best-practice approaches to so far lesser resourced crops.

Research questions

ReFOCUS, DISCOVER: What are promising high priority pest and resistance traits where genomic-assisted tools can aid in effectively introgressing these traits into elite germplasm?

ACCELERATE: How do we develop robust data to support variety selection aligned with product profiles and farmers' actual, low-input growing conditions? How do we develop robust data to support genomic-assisted rapid-cycle recurrent selection?

ACCELERATE: How do we maximize genetic gain per year whilst maintaining sufficient genetic variance? How do we leverage breeding investments across product profiles and target markets?

Components of Work Packages

DISCOVER: CGIAR-NARES breeding pipelines are supported by TD&D programs that deliver high-impact traits within elite parental lines, including for pest and disease resistance.

ACCELERATE: CGIAR-NARES-SME 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, which in most cases implies low or lower-input conditions.

Measuring performance and results

- Productivity increase under farmer-relevant conditions.

. Diversity of crops and product profiles supported, including as evidenced by genomic analysis.

Partners

The key demand for productivity increases and new diversity – including for resistance to new pests and diseases or end use characteristics – comes from farmers and market participants, as further established by MIPP. ABI will work with N4ETTS, advanced research institutes and the multinational breeding sector to apply fast and efficient breeding approaches within its networks.

Human resources and capacity development of Initiative team

As driven by the organization and implementation of more effective breeding approaches across ABI.

6. Monitoring, evaluation, learning and impact assessment (MELIA)

6.1 Result framework

Accelerated Breeding Initiative (ABI) Results Framework Table. Accelerated Breeding Initiative (ABI) Impact Areas, collective global 2030 targets, common impact indicators and SDGs. Action Area Outcomes.

	Impact Area 1	**Impact Area 2**	**Impact Area 3**	**Impact Area 4**	**Impact Area 5**
Title	**Nutrition, health and food security**	**Poverty reduction, livelihoods and jobs**	**Gender equality, youth and social inclusion**	**Climate adaptation and mitigation**	**Environmental health and biodiversity**
Collective global 2030 targets			The collective global 2030 targets are available centrally here to save space.		
Common impact indicators	#people benefiting from relevant CGIAR innovations **- reported in collaboration with MIPP**	#people benefiting from relevant CGIAR innovations **- reported in collaboration with MIPP**	#women benefiting from relevant CGIAR innovations **- reported in collaboration with MIPP** #youth benefiting from relevant CGIAR innovations **- reported in collaboration with MIPP**	#people benefiting from climate-adapted innovations **- reported in collaboration with MIPP**	#ha under improved management **- reported in collaboration with MIPP**
SDG target #s	2.1, 2.2	1.1, 2.3	5.5	1.5, 13.1	2.4

Genetic Innovation Action Area Outcomes	**Genetic Innovation Action Area Outcome Indicators**
CGIAR and partners use high-quality market intelligence to guide the development of new varieties to meet the needs and expectations of a wide-range of users, with special attention to marginalized groups.	Proportion of new released varieties developed in alignment with market intelligence-informed product profiles
CGIAR and partner breeding programs use best practices and shared services to rapidly and efficiently produce new varieties with in-demand traits.	Realized and predicted rates of genetic gain in farmer's fields and farmer relevant-conditions in the form of farmer-preferred varieties
	Increase in the capacity of CGIAR-NARES-SME breeding networks
Cooperation and co-investment by CGIAR, public- and private-sector seed-system actors supports coordinated and effective research and investment in the sector	Number of genetic innovations commercialized through public/private sector cooperation agreements.
	Number of public/private sector cooperation agreements
Women and youth are empowered to be more active in decision making in food, land and water systems	Number of farmers who grow market intelligence-informed new crop varieties, disaggregated by gender and age

Result type	Result	Indicator (use the common indicator list above)	Unit of measure-ment	Geo-graphic scope	Data source	Data collection method	Frequency of data collection	Baseline value	Baseline year	Target value	Target year
Outcome	Breeding focused on farmers' needs and drivers of impact.	Proportion of targeted breeding pipelines clearly mapping to product profiles, TPEs and market segments	%	Global	Crops reports	Criteria-based assessment	Semi-annual	0%	2021	75%	2024
Outcome	Enhanced alignment of breeding investment with the 5 Impact Areas.	Proportion of targeted programs having fully costed investment in breeding results aligned with each of the five Impact Areas.	%		Costing studies	ABI	Annual	0%	2021	75%	2024
Outcome	Improved operational clarity, effectiveness, and communication in breeding networks	Proportion of targeted breeding networks implementing new organizational frameworks and enabling tools.	%		Crops reports	Criteria-based assessment	Semi-annual	0%	2021	80%	2024
Outcome	Increased gender diversity in CGIAR breeding teams	Proportion of professional roles within targeted breeding teams occupied by women	%		CGIAR reports	Staff lists	Annual	Not available	N/A	+10 %	2024
Outcome	Targeted NARES & SMEs have increased responsibility and participation in processes and decision making	Proportion of targeted breeding Networks demonstrating and documenting clear co-attribution of variety development to multiple stakeholders.	%		Crops reports	Criteria-based assessment	2022, 2024	Not available	N/A	80%	2024
Outcome	Strengthened/increased NARES and SMEs capacity to participate in breeding networks and develop varieties.	Proportion of targeted NARES/SMEs increasing in capacity ratings	%					Not available	N/A	+80 %	2024
Outcome	Stronger prioritization applied to targeted TD&D projects	Proportion of targeted programs with lists of resourced prioritized TD&D projects and lists of projects canceled or shelved.	%				Semi-annual	0	N/A	80%	2024
Outcome	TD&D pipelines have mainstreamed best practices for development of prioritized donor germplasm.	Proportion of targeted TD&D pipelines demonstrating best practice implementation	%					0	2021	70%	2024
Outcome	Targeted population improvement pipelines increase predicted rates of genetic gain.	Proportion of targeted programs increasing predicted rates of genetic gain to >1%	%					Not available	N/A	70%	2024

		or doubling baseline (whichever achieved first).									
Outcome	Increased testing of breeding products in famer-relevant, product profile representative conditions.	Proportion of targeted pipelines able to capture target product profile traits under farmer-relevant conditions.	%					Not available	N/A	75%	2024
Outcome	Increased demand and access to CGIAR-NARES germplasm by seed system partners	Increase in number of lines and varieties demanded by seed system partners	%		SeEd QUAL	Survey	2022, 2024	Not available	N/A	+20 %	2024
REFOCUS											
Output	Portfolio of distinct, achievable product profiles	Feasibility of (current) product profiles revised and completed in a crop.	% Crops	Global	Crops reports	On-line MEL Tool	Semi-annual			100	2024
Output	Strategic breeding segment targeting	Strategic approach for advancing each trait on each product profile with population improvement, TD&D or both	% Crops	Global	Crops reports	On-line MEL Tool	Semi-annual			80	2024
Output	Realistic breeding ambitions, associated costs and timelines	Portfolio of pipeline investment cases	% pipelines in portfolio	Global	Crops reports	On-line MEL Tool	Semi-annual			80	2024
Output	Product profile aligned selection indexes	Trait emphasis during selection, based on trait importance and impact, defined, documented and deployed.	% Crops	Global	Crops reports	On-line MEL Tool	Semi-annual			75	2024
ReORGANIZE											
Output	High level organizational structure	High level organizational structure defined (Y1).	% Achievement	Global	WP report	On-line MEL Tool	Semi-annual			100	2024
Output	Stage gates and handover criteria	Common stage gates (Y1) and commodity/pipeline-specific stage gates defined (Y2).	% Achievement	Global	WP report	On-line MEL Tool	Semi-annual			100	2024
Output	RACI for breeding teams	RACI framework drafted (Y1), validated (Y2) and implemented (Y3).	% Achievement	Global	WP report	On-line MEL Tool	Semi-annual			80	2024
Output	Common KPI system	Breeding performance-oriented KPIs for developed (Y1), validated (Y2), reported (Y3).	% Achievement	Global	WP report	On-line MEL Tool	Semi-annual			80	2024
TRANSFORM											

Output	Network membership prioritization	Prioritization criteria for membership defined (Y1) and implemented (Y2).	% Achievement	Global	WP report	On-line MEL Tool	Semi-annual			80	2024
Output	Network agreements	Network agreement drafted (Y1) and agreed (Y2).	% Achievement	Global	WP report & Signed Agreements	On-line MEL Tool	Semi-annual			100	2024
Output	Open access support for germplasm and knowledge	Mechanism for open access support drafted (Y1) and agreed (Y2).	% Achievement	Global	WP report	On-line MEL Tool	Semi-annual			100	2024
Output	Transparent, inclusive processes for decision making	Approaches for NARES and SMEs participation in key decision-making documented and agreed.	% Breeding networks	Global	Crops reports	On-line MEL Tool	Semi-annual			80	2024
Output	Transparent, inclusive processes for co-creation	Baseline and augmented roles of each NARES, SME & ARI in crop networks defined.	% Breeding networks	Global	Crops reports	On-line MEL Tool	Semi-annual			50	2024
Output	Partner assessments	Partners strengths established: high-level.	% Breeding networks	Global	Crops reports	On-line MEL Tool	Semi-annual			80	2024
Output	Partner assessments	Partners strengths established: in-depth.	NARES Members	Global	WP report	On-line MEL Tool	Semi-annual			6	2024
Output	Improvement plans	Improvement plans established.	NARES Members	Global	WP report	On-line MEL Tool	Semi-annual			6	2024
Output	Needs-based training	Capacity development plans established.	NARES Members	Global	WP report	On-line MEL Tool	Semi-annual			12	2024
Output	Metrics to assess network and partnership quality and output	Metrics to assess crop breeding networks for partnership quality and germplasm output drafted (Y1), agreed (Y2), applied (Y3).	% Achievement	Global	WP report	On-line MEL Tool	Semi-annual			80	2024
DISCOVER											
Output	Anticipated ROI and likelihood of success of TD&D projects	TD&D projects reviewed and aligned with ROI.	% Crops	Global	Crops reports	On-line MEL Tool	Semi-annual			70	2024
Output	Best practice approaches for highest priority TD&D scenarios	TD&D projects reviewed and aligned with best practice approaches.	% High-ROI TD&D	Global	Crops reports	On-line MEL Tool	Semi-annual			70	2024

			projects								
Output	Lean, outcome-oriented and informative KPI system	KPIs for TD&D developed (Y1), validated (Y2), reported (Y3).	% Crops	Global	Crops reports	On-line MEL Tool	Semi-annual			80	2024
Output	Elite parental trait donors carrying highly valuable, in-demand traits	Use of donors in population improvement pipeline(s)	% pipelines	Global	Crops reports	On-line MEL Tool	Annual			70	2024
ACCELERATE											
Output	Improvement plans	Improvement plans reviewed, annually.	% Crops	Global	Crops reports	On-line MEL Tool	Semi-annual			100	2024
Output	Genomics-supported RSS schemes	Pipeline cycle time	% reduction of cycle time	Global	Crops reports	On-line MEL Tool	Semi-annual			-30	2024
Output	Genomics-supported RSS schemes	Genome-assisted RCRS developed and implemented.	% Pipelines	Global	Crops reports	On-line MEL Tool	Semi-annual			70	2024
Output	Optimized breeding pipelines, pipeline structure and germplasm sharing	GxE analysis of past testing data completed, minimum 3 years. Germplasm sharing strategy documented.	% Crops	Global	Crops reports	On-line MEL Tool	Semi-annual			70	2024
Output	Optimized variety extraction	AlphaSim applied to optimize variety extraction.	% Crops	Global	Crops reports	On-line MEL Tool	Semi-annual			50	2024
Output	Farmer-and market-relevant variety identification schemes	Testing strategy capturing product profile characteristics, the TPE and farmers' conditions, passing peer review.	% Crops	Global	Crops reports	On-line MEL Tool	Semi-annual			80	2024
Output	Farmer-and market-relevant variety identification schemes	Cost per plot maintaining or increasing heritability.	% decrease	Global	Crops reports	On-line MEL Tool	Semi-annual			10	2024
Output	On-farm testing approaches	On-farm testing approaches executed (> 30 sites).	% Breeding networks	Global	Crops reports	On-line MEL Tool	Semi-annual			30	2024
Output	CGIAR and NARES candidate varieties and trait donors meeting target product profiles	Mean number per pipeline (across portfolio) of candidate varieties that meet the target product profile requirements.	Number	Global	Crops reports	On-line MEL Tool	Semi-annual			3	2024

6.2 MELIA plan

MEL plan

The monitoring and evaluation plan has four main components. Together with the Impact Assessment research plans, they will also develop crucial data for external evaluations.

On a semi-annual basis, ABI will collect and assess output-related indicators that together form a criteria-based assessment of outcome indicators # 1, 3, 5-10. The first data collection will define the base line value. They will assess **to what extent CGIAR-NARES-SME networks are able to implement improved breeding approaches**, including those from N4ETTS, **and what hinders their adoption**. Insights will be discussed and used to adjust crop-specific improvement plans, sequencing and emphasis between approaches, and investments.

Breeding gain assessments will be further standardized for routine implementation, based on type of breeding objective pursued (productivity, resilience, end use or nutritional characteristics) and testing stage. These will be compared with on-farm verification by SeEdQUAL and other seed systems actors to assess **to what extent ABI breeding teams are able to realize the expected breeding gains.** Insights will be used to adjust trait emphasis and testing schemes, assess and incentivize breeding teams.

ReORGANIZE will implement **a redefinition of organizational structure, stage gates and handover criteria, RACI and KPIs.** TRANSFORM will develop metrics to assess **partnerships strength and network performance**. Their creation and implementation both entail key learnings for (i) teams to better understand responsibilities and be incentivized by clear outcome indicators, (ii) ABI, crop and network managers to understand bottlenecks and achievements, and take corrective actions as appropriate.

In addition to TRANSFORM implementing assessment tools to inform the definition of partners' roles, improvement and capacity development plans; **external BPAT assessments** are expected to continue over the investment period. This will establish progress and bottlenecks in implementing ABI's and N4ETTS's change agenda.

Impact Assessment research plans

Impact Assessment for ABI varieties is part of the combined Genetic Innovation Action Area's Impact Assessment, and executed by MIPP and SeEdQUAL. They will assess reach and include benefit assessments.

Together with MIPP, ABI will make ex-ante assessments to define **to what extent CGIAR breeding pipelines are targeted at market segments and product profiles that are expected to create the most benefits**. They will be cross-verified with scientific studies and stakeholder insights, in particular from seed systems actors, and discussed with funders. Insights are expected to be forthcoming during the entire investment period, as described in Section 2.4, and will result in ABI adjusting investments between crops and market segments, or product profile characteristics.

Together with SeEdQUAl, ABI will assess **to what extent seed systems actors will increase their investments in scaling-up new varieties from CGIAR breeding pipelines, and underlying reasons for adoption and non-adoption**. Data will be collected through structured surveys executed at the end of 2022 and 2024. Those will be cross-verified with insights from MIPP Work Packages 1 and 4. Insights may lead to adjusting product profiles, approaches to germplasm sharing, approaches to partner involvement during variety identification, SeEdQUAL support to seeds system actors and other scaling strategies.

6.3 Planned MELIA studies and activities

Type of MELIA study or activity planned	State the result or indicator that the MELIA study or activity will contribute to – Select from Tables A, B or C.	Anticipated year of completion (based on 2022-24 Initiative timeline)	Co-delivery of planned MELIA study or activity with other Initiatives	How the MELIA study or activity planned will inform management decisions and contribute to internal learning
Ex-ante foresight study	Development of varieties with focus on farmers' needs and drivers of impact (Results Framework)	2024	MIPP	Adjusting breeding investments between market segments and product profiles
Adoption studies addressing learning questions on the TOC	Indicator # 1, 3, 5-10 in Results Framework	2024	N4ETTS	Adjusting improvement investments
Scaling Readiness Assessment study	Identification of candidate varieties with a step-change in performance under farmers' conditions (Results Framework)	2024	SeEdQUAL	Adjusting improvement investments
Tracing of scaling activities, as base for long-term, large scale impact studies	Cooperation and co-investment by CGIAR, public- and private-sector seed-system actors supports coordinated and effective research and investment in the sector (Results Framework Table)	2024	SeEdQUAL	Adjusting improvement investments
Scaling Readiness Assessment Study	9 Innovation Packages have undergone evidence-based and quality controlled/ validated Scaling Readiness assessments informing innovation and scaling strategies	5 - 2023 4 - 2024	MIPPI, N4ETTS, SeEdQUAL	The study will inform the design, implementation and monitoring of an innovation and scaling strategy, and scaling readiness metrics can feed an optional Initiative innovation portfolio management system

7. Management plan and risk assessment

7.1 Management plan

The Initiative will be led and managed by an overall lead and five Work Package leads overseeing the implementation of the change agenda. Work Package leaders will interact with and support distinct functional roles in the crop breeding programs: 1. Portfolio Managers; 2. Process Managers; 3. Network Leads; 4. TD&D Leads; 5. Breeding Leads and Phenotyping Leads. The overall accountability for crop-specific implementation will be with the Crop Leads who will report to the ABI Lead. Pro-active change management approaches will be implemented, using team-based approaches for co-creation and learning within Work Packages. An advisory board will review progress and provide guidance to the overall management and implementation of the initiative.

The outcome indicators described in the Results Framework Table, and associated output indicators, will be the basis for measuring progress. Some outputs have a sequential, time-bound logic, typically those where systematic scaling across crops is required. Other outputs will not be achieved by all crops at the same time and in the same sequence, given crop-specific interdependencies. Crop Leaders will develop crop-specific plans outlining when each indicator will be achieved, also why some lower-level outputs may not be applicable in their crop. Achievement of indicators will be reviewed semi-annually (Q1 and Q3). They form the basis for systematizing key learnings, their relevance to the TOC, and for assessing whether risks can be effectively managed. They influence resourcing of both dimensions (crops and Work Packages), including planning for use of CtEH resources. Q3 will inform next-year workplans and budgets and, together with projection of benefit insights from ReFOCUS, enable systematic re-prioritization towards the most impactful activities. Crop-specific plans will also help coordinate ABI and N4ETTS technical support to crops.

7.2 Summary management plan Gantt table

Initiative Start Date	Jan 01, 22	Timelines												Description of key deliverables for targeted pipelines
		2022				2023				2024				
Work Packages	Lead organization	Q 1	Q2	Q3	Q4	Q 1	Q2	Q 3	Q4	Q 1	Q2	Q3	Q4	
ReFOCUS	TBD		1 /2	3	1/2/3	1	2	3		1	2	3		1. Product profiles defined and reviewed. 2. Alignment and costs of pipelines described and reviewed. 3. Resourcing of pipelines reassessed.
ReORGANIZE	TBD			4			5						6	4. Organizational framework defined, 5. Stage Gates, RACI and KPIs defined 6. Fully implemented
TRANSFROM	TBD			7					7/8				7/8	7. Network processes and partnership strength assessed; plan for next steps developed 8. Capacity development and technical support to NARES & SME, with annual review of strength of networks.
DISCOVER	TBD				9/10				10				10	9. ROI framework defined. 10. Best practice support provided to TD&D projects implementing iterative improvements and stop-go decisions.
ACCELERATE	TBD			12/13	11	12	13		11	12	13		11	11. Annual revision of prioritized crop improvement plans. 12. realized and predicted rate of genetic gain reported. 13. Trialing strategy reported and reviewed; plans for next steps developed.
Innovation Packages & Scaling Readiness	TBD	14		15/16				17						IP# 1, 3, 4, 6, 8: Light track (14); Standard track (15). IP# 2, 5, 7, 9: Light track (16); and Standard track (17).
MELIA	TBD			18/20	19	18		18	19	18		18/20		18. Assessment of outcome indicators stimulating iterative learning. 19. Adjusting breeding investments based on projection of benefits. 20. Seed sector survey.
Project Management	TBD				21				21				21	21. Next-year workplans and budgets approved, and ABI report compiled.

7.3 Risk assessment

Top 5 risks to achieving impact (WP #)	**Description of risk**	Likeli-hood 1-5	Impact 1-5	Risk score	**Opportunities for Risk Mitigation**
Operational: Data Impedance (1)	Efforts and time taken to generate large amounts of market intelligence data paralyzes the product profile revision process; programs continue to pursue inadequately targeted priorities	4	3	12	• Implementation of iterative/ step-wise improvements of product profile descriptions with prioritization of most impactful data. • Pragmatic process integrating available data with weighting based on data quality and risk of use/not using data. • Effective outcome-focused communication between MIPP and ReFOCUS.
Operational Culture: Resistance to change (2)	Resistance to operational and culture changes impedes the effective implementation of modernization and aligned, outcome-oriented breeding	4	4	16	• Use of change management strategies and processes. • Aligned leadership and sponsorship of change. • MEL indicators that monitor the extent of change
Fit for Purpose Partnerships: Empowered NARES and SMEs (3)	NARES and SMEs are not empowered and enabled to collaborate in breeding decision making and processes, resulting in failure to develop and deliver results	3	3	9	• Ensuring alignment between network and country priorities • Use of metrics that define and assesses partnership quality and network output, in qualitative and quantitative terms (in TRANSFORM).
Science: Breeding targets missed (4,5)	Breeding pipeline segments fail to appropriately define targets and incorporate feedback from next users	3	4	12	• Cohesive multi-stakeholder and multidisciplinary feedback mechanisms appropriately implemented in stage-gate processes (in ReORGANIZE).
Science: Inappropriate use of tools and methods (4,5)	Breeding pipelines use sub-optimal tools and scientific methodologies resulting in poor delivery of results.	4	4	16	• Definition and scaling of best practices with progress captured by MEL. • Strategic and operational partnership with N4ETTS. • Resources available for optimal use of tools and implementation of best practice methodologies.

8. Policy compliance, and oversight

8.1 Research governance

Researchers involved in the implementation of this Initiative will comply with the procedures and policies determined by the System Board to be applicable to the delivery of research undertaken in furtherance of CGIAR's 2030 Research and Innovation Strategy, thereby ensuring that all research meets applicable legal, regulatory and institutional requirements; appropriate ethical and scientific standards; and standards of quality, safety, privacy, risk management and financial management. This includes CGIAR's CGIAR Research Ethics Code and to the values, norms and behaviors in CGIAR's Ethics Framework and in the Framework for Gender, Diversity and Inclusion in CGIAR's workplaces.

8.2 Open and FAIR data assets

Researchers involved in the implementation of this Initiative shall adhere to the terms of the Open and FAIR Data Assets Policy and be aligned with any specific directives on data dissemination from plant genetic resources developed by the International Treaty on Plant Genetic Resources and ratified by participating countries. The Accelerated Breeding Initiative will align with the OFDA Policy's Open and FAIR requirements, ensuring:

- Rich metadata conforming to the CGIAR Core Schema to maximize Findability, including geolocation information where relevant.
- Accessibility by utilizing unrestrictive, standard licenses (e.g. Creative Commons for non-software assets, General Public License (GPL))/Massachusetts Institute of Technology (MIT) for software), and depositing assets in open repositories.
- Wider access through deposition in open repositories of translations and requiring minimal data download to assist with limited internet connectivity.
- Interoperability by annotating dataset variables with ontologies where possible (controlled vocabularies where not possible).
- Adherence to Research Ethics Code (Section 4) relating to responsible data (through human subject consent, avoiding personally identifiable information in data assets and other data-related risks to communities).

9. Human resources

9.1 Initiative team - Table

Role	*Category*	*Area of expertise*	*Short description of key accountabilities*
Initiative Lead	Research	Research and partnership management, scientific leadership, Strategic Vision, Team Building	Setting a vision, providing leadership across ABI Work Packages, linking with other One CGIAR Initiatives, building the Initiative leadership team.
Work Package Coordinators/ Leads and professionals	Research	Research and partnership management, scientific leadership, stakeholder management	Provide WP leadership, drive the change agenda, implement the management plan with cross-commodity teams; ensure learning; establish external collaborations.
MEL / Internal communication	Non-Research	Project management and MEL	Ensuring effective project / workplan implementation. Tracking M&E. Annual reporting.
Innovation Scaling	Non-Research	Scaling readiness assessment and process, communication	Ensure sound approaches to scaling within and among WPs and with other Initiatives.
Crop Leads	Research	Crop-specific research and partnership management, scientific leadership, breeding processes	Crop breeding leadership, develop ABI-aligned prioritized improvement plans; accountable for the crop specific implementation of the Work Packages.
Portfolio Managers	Research	Portfolio management at the intersection of breeding, socio-economics and stakeholder perspectives.	Manage the portfolio of product profiles, and associated market segments, across multiple crops and incorporate the improvements made by MIPPI and breeding teams. Coordinate and lead advancement meetings.
Breeders	Research	Molecular and field-based plant breeding, quantitative genetics, data-driven decision making	Implement population improvement, generate advancement data and provide technical input to product profiles (feasibility) and breeding networks.
TD&D specialists	Research	Genetics (quantitative, molecular, physiological).	Implement trait discovery and deployment, trait augmentation in key lines.
Phenotyping specialists	Research	Physiology, pathology, nutritional and end-use quality assessments, trialing team	Contribute to/ implement variety identification. Develop methodology for high throughput phenotyping aligned to product profile needs, identify trait donors
Network Coordinators	Research /Non-Research	Network coordination, public-private partnerships	Lead CGIAR-NARES-SME networks; accountable for inclusive and effective processes and capacity development
On-farm Assessment	Research	On-farm variety evaluation at scale	Oversee and support crop-specific on-farm testing trialing.
Operations Team	Research / Non-Research	Execute operations for breeding, phenotyping and TD&D teams,	Execute network operations, end-to-end: seed storage, field and laboratory operations, seed health, data management (closely aligned with N4ETTS)
Non-research support	Non-research	Finance, administration, legal, HR	Support and track budgets, legal agreements, administration (logistics, personnel etc.).
Communication Lead	Non-research	Communications	Ensure effective internal and external communication of Initiative progress and achievements
External experts	Research / non-research	Distinct technical and management expertise	Supporting distinct objectives of the Initiative on a consultancy basis.

9.2 Gender, diversity and inclusion in the workplace

Gender, diversity, and social inclusion are core to the goals of ABI's research agenda. The Initiative team is unlikely to meet CGIAR's gender target of a minimum of 40% women in professional roles and/or may not be sufficiently comprised of individuals from diverse backgrounds, given current gender balance among staff. It would imply active retrenchment of current staff. We will prioritize gender balance and diversity when recruiting and follow the guidance outlined in CGIAR's GDI Inclusive Recruitment Toolkit.
Women, minorities, and other under-represented groups will hold leadership roles in the Initiative team wherever possible. This will be supported by:

- Providing leadership development training and mentoring opportunities to women, minorities, and other under-represented groups so that they will be better represented in leadership positions going forward.
- Ensuring there is fair allocation of leadership activities and accountabilities among the team when assigning roles and decision rights.
- Requiring all our team members to take CGIAR's Panel Pledge and actively include under-represented colleagues

ReORGANIZE will design and implement a new organizational framework of specialized yet integrated teams. It is expected that this will attract more women into breeding, given that they make the majority in certain breeding-related disciplines. The framework places greater emphasis on making transparent contributions to outputs and outcomes, facilitating greater impartiality in the attribution of good performance and team behavior, and reducing opportunities for socio-cultural biases including gender. RAPID and other tools will be applied to team management to overcome power differentials.

9.3 Capacity development

1. Initiative team leaders and managers will complete training on inclusive leadership within three months of launch.
2. Within six months of launch, Initiative team members will complete training on gender, diversity and inclusion, including on whistleblowing and how to report concerns.
3. The Initiative kick-off will include an awareness session on CGIAR's values, code of conduct and range of learning opportunities available within CGIAR.
4. Development opportunities will be made available for junior level Initiative team members, partners and stakeholders, including (for example: Mentorship, Internships/scholarships with representation of emerging professionals from under-represented groups, conference attendance, etc.).
5. Initiative, Work Package and crop leaders will be trained on scaling readiness and change management methods and processes.
6. The entire team (~100 people) will be trained on the theory of change, MELIA and the management plan.
7. Work Package specific trainings and workshops will be executed for CGIAR, NARES and SME network members; for example:
    a. Market segments, product profiles and TPEs.
    b. Implementing stage gates, RACI, RAPID and KPIs.
    c. CGIAR-NARES-SME partnership models.
    d. Best practices for separating TD&D from variety development and current best practice TD&D approaches.
    e. Redesigning breeding schemes and approach. Including principles of quantitative genetics and methods for incorporating increased on-farm trialing.

8. Technical support to implement crop-specific, center and NARES improvement plans
9. Use of CtEH resources to enhance organizational breeding capacity.

10. Financial resources

10.1 Budget

10.1.1: Activity breakdown

USD	2022	2023	2024	Total
Crosscutting across Work Packages	1,673,469	1,816,085	1,977,994	5,467,548
Work Package 1	1,681,500	1,811,000	1,957,000	5,449,500
Work Package 2	672,600	724,400	782,800	2,179,800
Work Package 3	6,726,000	7,244,000	9,785,000	23,755,000
Work Package 4	4,371,900	4,708,600	5,088,200	14,168,700
Work Package 5	18,219,334	19,558,800	19,129,466	56,907,600
				0
Innovation packages & Scaling Readiness	344,331	357,115	370,406	1,071,852
Total	**33,689,134**	**36,220,000**	**39,090,866**	**109,000,000**

10.1.2: Geography breakdown

USD	2022	2023	2024	Total
Global	33,689,134	36,220,000	39,090,866	109,000,000
Total	**33,689,134**	**36,220,000**	**39,090,866**	**109,000,000**

Annexes

Annex PB: Projected benefits:

- Find at: www.dropbox.com/sh/zqli9rc1214exi4/AADILTtNSCGvegfb3V7DwqVVa?dl=0
    - Projected Benefits GI_Section 2.7_Annex_Sept 27_FINAL
    - Projected Benefits_GI_Section 2.7_Sept 27_final
    - Projected Benefits Template_Beans_Sept 27_with 2024
    - Projected Benefits Template_Cassava_Vit A_27 Sept_with overlap and 2024
    - Projected Benefits Template_High Yield Rice_Sept 27_with 2024
    - Projected Benefits Template_Maize_Stress Tol_Sept_27_with 2024
    - Projected Benefits Template_OFSP_Vit A_27 Sept_with 2024
    - Projected Benefits Template_Wheat_Sept_27_with 2024 and rice overlap

Annex SL: Support letters

- 20 letters of support for ABI from NARES, universities and other partner institutions
- Find at: www.dropbox.com/sh/vfn5ho9p9ebk1qj/AADtv4y8PQsGa47jdvxAgl1Pa?dl=0
    - A&F University, Nepal
    - ACCI
    - ANGRAU, India
    - BINA- Bangladesh
    - BRRI, Bangladesh
    - CBI
    - CORAF
    - CRI Ghana
    - Director Research, IGKV, India
    - EIAR Ethiopia
    - GBioS_University of Abomey Calavi
    - IARI, India
    - ICAR-NRRI, India
    - IGKV, India
    - MaRCCI Uganda
    - NARO
    - Nepal ARC, Nepal
    - NWRP, Nepal
    - TARI
    - WACCI

References

Atlin, G.A., Cairns, J.E and Das, B. (2017). Rapid breeding and varietal replacement are critical to adaptation of cropping systems in the developing world to climate change. Global Food Security 12, 31-37. https://doi.org/10.1016/j.gfs.2017.01.008

Challinor, A.J., Watson, J., Lobell, D.B., Howden, S.M., Smith, S.R. and Chhetri, N. (2014). A meta-analysis of crop yield under climate change and adaptation. Nature Climate Change 4, 287–291. https://doi.org/10.1038/nclimate2153

Basavalingaiah, K., Ramesha, Y.M., Paramesh, V., Rajanna, G.A., Jat, S.L., Dhar Misra, S., Kumar Gaddi A., Girisha, H.C., Yogesh, G.S., Raveesha, S., Roopa, T.K., Shashidhar, K.S., Kumar, B., El-Ansary, D.O., Elansary, H.O. (2020). Energy Budgeting, Data Envelopment Analysis and Greenhouse Gas Emission from Rice Production System: A Case Study from Puddled Transplanted Rice and Direct-Seeded Rice System of Karnataka, India. Sustainability 12(16), 6439. https://doi.org/10.3390/su12166439

Bernal-Galeano, V., Norton, G., Ellis, D., Anglin, N. L., Hareau, G., Smale, M., Jamora, N., Alwang, J. and Pradel, W. (2020). Andean potato diversity conserved in the International Potato Center GeneBank helps develop agriculture in Uganda: the example of the variety 'Victoria'. *Food Security* 12(5), 959–973. https://doi.org/10.1 007/s12571-020-01037-8

Bhatt, R., Kubal, S., Busari, M.A., Arora, S. and Yadav, M. (2016). Sustainability issues on rice–wheat cropping system. International Soil and Water Conservation Research, Vol. 4 (1): 64-74.

Black, R.E., and M. Ezzati. 2015. Trends and mortality effects of vitamin A deficiency in children in 138 low-income and middle-income countries between 1991 and 2013: a pooled analysis of population-based surveys. Lancet Glob. Health 3, e528–e536. https://doi.org/10.1016/S2214-109X(15)00039-X

Byerlee, D., Stevenson, J., Villoria, N. (2014) Does intensification slow crop land expansion or encourage deforestation? Global Food Security 3, 92-98 https://doi.org/10.1016/j.gfs.2014.04.001

Cairns, J.E., and Prasanna, B.M. (2018). Developing and deploying climate-resilient maize varieties in the developing world. Current Opinions in Plant Biology 45, 226-230. https://doi.org/10.1016/j.pbi.2018.05.004

Crespo-Herrera, L.A., Crossa, J., Huerta-Espino, J., Autrique, E., Mondal, S., Velu, G., Vargas, M., Braun, H.J., and Singh, R.P., 2017. Genetic yield gains in CIMMYT'S international elite spring wheat yield trials by modeling the genotype × environment interaction. Crop Science 57: 789–801. https://doi.org/10.2135/cropsci2016.06.0553

Garrett, K.A., Andersen, K.F., Asche, F., Bowden, R.L., Forbes, G.A., Kulakow, P.A., and Zhou B. (2017). Resistance Genes in Global Crop Breeding Networks. Phytopathology 107, 1268-1278. https://doi.org/10.1094/PHYTO-03-17-0082-FI.

Ismail, A.M., and Mackill, D.J. (2013). Response to flooding: submergence tolerance in rice. In: Jackson M, Ford-Lloyd B, Parry M, eds. Plant genetic resources and climate change. Wallingford, UK: CAB International, 251–269.

Juliana, P., Singh, R.P., Braun, H-J., Huerta-Espino, J., Crespo-Herrera, L., Govindan, V., Mondal, S., Poland, J., and Shrestha, S. (2020) Genomic Selection for Grain Yield in the CIMMYT Wheat Breeding Program—Status and Perspectives. Front. Plant Sci. 11:564183. https://doi.org/10.3389/fpls.2020.564183

Karwat, H., Moreta, D., Arango, J. et al. Residual effect of BNI by Brachiaria humidicola pasture on nitrogen recovery and grain yield of subsequent maize. Plant Soil 420, 389–406 (2017). https://doi.org/10.1007/s11104-017-3381-z

Katungi, E.M., Larochelle, C., Mugabo, J.R. et al. (2018). The effect of climbing bean adoption on the welfare of smallholder common bean growers in Rwanda. Food Sec. 10, 61–79. https://doi.org/10.1007/s12571-017-0753-4

Krishna, V.V., Lantican, M.A., Prasanna, B.M., Pixley, K.V., Abdoulaye, T., Menkir, A., Bänziger, M., and Erenstein, O. (2021). Impacts of CGIAR Maize Improvement in sub-Saharan Africa, 1995-2015. Mexico, CDMX, International Maize and Wheat Improvement Center (CIMMYT). https://repository.cimmyt.org/handle/10883/21292

Kumar, A., Raman, A., Yadav, S., Verulkar, S.B., Mandal, N.P., Singh, O.N., Swain, P., Ram, T., Badri, J., Dwivedi, J.L., Das, S.P., Singh, S.K., Singh, S.P., Kumar, S., Jain, A., Chandrababu, R., Robin, S., Shashidhar, H.E., Hittalmani, S., Satyanarayana, P., Venkateshwarlu, C., Ramayya, J., Naik, S., Nayak, S., Dar, M.H., Hossain, S.M., Henry, A., Piepho, H.P. (2021). Genetic gain for rice yield in rainfed environments in India. Field Crops Res. 260:107977. doi: 10.1016/j.fcr.2020.107977. PMID: 33390645; PMCID: PMC7722510.

Ladha, j.K., D Dawe, H Pathak, A.T Padre, R.L Yadav, Bijay Singh, Yadvinder Singh, Y Singh, P Singh, A.L Kundu, R Sakal, N Ram, A.P Regmi, S.K Gami, A.L Bhandari, R Amin, C.R Yadav, E.M Bhattarai, S Das, H.P Aggarwal, R.K Gupta, P.R Hobbs (2003). How extensive are yield declines in long-term rice–wheat experiments in Asia? Field Crops Research, Vol. 81(2–3): 159-180.

Letaa, E., Katungi, E., Kabungo, C., and Ndunguru, A.A. (2020) Impact of improved common bean varieties on household food security on adopters in Tanzania, Journal of Development Effectiveness, 12:2, 89-108, DOI: 10.1080/19439342.2020.1748093

Mudege, N.N., Mayanja, S., and Muzhingi, T. (2017). Women and men farmer perceptions of economic and health benefits of orange fleshed sweet potato (OFSP) in Phalombe and Chikwawa districts in Malawi. *Food Security* 9.2: 387-400. https://doi.org/10.1007/s12571-017-0651-9

Prasanna, B.M., Cairns, J.E., Zaidi, P.H., Beyene, Y., Makumbi, D., Gowda, M., Magorokosho, C., Zaman-Allah, M., Olsen, M., Das, A., Worku, M., Gethi, J., Vivek, B.S., Nair, S.K., Rashid, Z., Vinayan, M.T., Issa, A.B., San Vicente, F., Dhliwayo, T., and Zhang, X. (2021). Beat the stress: Breeding for climate resilience in maize for the tropical rainfed environments. Theoretical and Applied Genetics 134, 1729-1752. https://doi.org/10.1007/s00122-021-03773-7

Pathak, H., Sankhyan, S., Dubey, D.S., Bhatia, A., and Jain, N. (2013) Dry direct-seeding of rice for mitigating greenhouse gas emission: field experimentation and simulation. Paddy Water Environ 11, 593–601. https://doi.org/10.1007/s10333-012-0352-0

Ray D.K., Gerber J.S., MacDonald G.K., and West, P.C.. (2015). Climate variation explains a third of global crop yield variability. Nature Communications, 6:5989. https://doi.org/10.1038/ncomms6989

Rovere, R.L., Abdoulaye, T., Kostandini, G., Guo, Z., Mwangi, W., MacRobert, J., ... Dixon, J. (2014). Economic, Production, and Poverty Impacts of Investing in Maize Tolerant to Drought in Africa: An Ex-Ante Assessment. The Journal of Developing Areas 48, 199-225. https://doi:10.1353/jda.2014.0016.

Setimela, P.S., Magorokosho, C., Lunduka, R., Gasura, E., Makumbi, D., Tarekegne, A., Cairns, J.E., Ndhlela, T., Erenstein, O., and Mwangi, M. (2017). On-Farm Yield Gains with Stress-Tolerant Maize in Eastern and Southern Africa. Agronomy Journal, 109: 406-417. https://doi.org/10.2134/agronj2015.0540

Stevens, G.A., Bennett, J.E., Hennocq, Q., Lu, Y., De-Regil, L.M., Rogers, L., Danaei, G., Li, G., White, R.A., Flaxman, S.R., Oehrle, S.-P., Finucane, M.M., Guerrero, R., Bhutta, Z.A., Then-Paulino, A., Fawzi, W., Black, R.E., and Ezzati, M. (2015). Trends and mortality effects of vitamin A deficiency in children in 138 low-income and middle-income countries between 1991 and 2013: A pooled analysis of population-based surveys. The Lancet Global Health 3(9), e528-e536. https://linkinghub.elsevier.com/retrieve/pii/S2214109X1500039X

Timsina, J. and Connor, D.J. (2001). Productivity and management of rice–wheat cropping systems: issues and challenges. Field Crops Research; Vol 69 (2): 93-132.

Westengen, O.T., Lusty, C., Yazbek, M. *et al.* Safeguarding a global seed heritage from Syria to Svalbard. *Nat. Plants* **6,** 1311–1317 (2020). https://doi.org/10.1038/s41477-020-00802-z

Wiebe, K., Sulser, T.B., Dunston, S., Rosegrant, M.W., Fuglie, K., Willenbockel, D.,a nd Nelson, G.C. (2021) Modeling impacts of faster productivity growth to inform the CGIAR initiative on Crops to End Hunger. PLoS ONE 16(4): e0249994. https://doi.org/10.1371/journal.pone.0249994.