



# Accelerating Genetic Gains in Maize and Wheat

## Current Period Progress: AGG Year 2 (2021) Executive Summary and Impact Report

The Accelerating Genetic Gains in Maize and Wheat (AGG) project has made strong progress towards all milestones and outcomes. From the lab to the field, AGG stakeholders are grateful to donors for supporting the ambition to improve maize and wheat breeding programs towards faster and better focused products and impacts. To this end, AGG scientists have designed and begun implementing substantial modifications to breeding targets and breeding schemes. AGG is also in a continuous improvement process for the partnership modalities, pursuing co-ownership and co-implementation that truly builds capacities of all involved. The following pages show a selection of highlights - an Executive Summary – of AGG's Year 2 achievements.



## Maize

### Optimization of breeding tools and methods to increase the rate of genetic gain.

- Reduced the breeding cycle for all product profiles from six to four years.
- Implemented rapid cycle genomic selection (RCGS) to further reduce breeding cycle length.
- Utilized genotypic information to select germplasm prior to the phenotyping stages, and this enabled the total number of genotypes within the breeding program to be expanded.
- Almost three-quarters of the product profiles in eastern and southern Africa (ESA) now rely on molecular markers to identify disease-resistant genotypes at the early stages of breeding prior to field testing.
- Implementing genomic selection (GS) using a “test-half-and-predict-half” approach has reduced breeding costs by 32% compared to the traditional phenotypic selection.

### Climate-resilient, input-responsive maize varieties developed for distinct product profiles and accessed by partners in sub-Saharan Africa (SSA).

- Ethiopia, Kenya, Uganda, Mozambique, Zambia, and Zimbabwe submitted 40 populations to the CIMMYT doubled haploid (DH) facility in Kenya.
- Identified haploid inducers with more than 9% oil content and a haploid induction rate greater than 10% to reduce haploid identification time from eight hours to one hour and decrease the labor requirement from eight people to one person per population, significantly lowering the cost per doubled haploid line.
- Delivered 4,000 DH lines to African breeders.
- Genotyped all Stage 1 lines from four product profiles in ESA with mid-density panels for genomic selection. Simulations indicated that recycling parents after Stage 1 can increase the genetic gain by 17% compared to recycling at Stage 3.
- Alignment of product profiles with defined market segments achieved in SSA, incorporating partners’ preferred trait matrices, and defining appropriate commercial and internal genetic checks to monitor genetic trends for the breeding pipelines.
- Monitored developments in all product profiles using a rolling genetic checks strategy that estimates gains in “real-time,” comparing against the best cultivars currently on the market and these results demonstrated product profiles are delivering 1.0 to 1.5% annual genetic gain.

### Accelerated varietal turnover and wider adoption of superior maize varieties in SSA by farmers, particularly women farmers;

- Developed 21 hybrids for advanced testing using marker-assisted backcrossing (MABC) for maize lethal necrosis (MLN) tolerance.
- Released 43 improved maize varieties in Kenya, Malawi, Mozambique, Zambia, Zimbabwe, Nigeria, and Ghana.
- Distributed 18 new high-yielding and stress-tolerant hybrids developed by CIMMYT to partners.
- Supplied over 170,000 MT of AGG-certified seed across 13 countries in SSA (Ethiopia, Kenya, Tanzania, Uganda, Malawi, Mozambique, South Africa, Zambia, Zimbabwe, Benin, Ghana, Mali,

and Nigeria), covering approximately 7.0 million ha, reaching an estimated 7.2 million households, ultimately benefiting 44 million people.

- Directed a Monitoring and Evaluation survey in West Africa with results showing certified seed coverage of the total maize area grew from 4% in 2011 to 32% in 2020, while the area-weighted average age declined from about 18.2 years in 2011 to 10.87 years in 2020.
- Expanded on-farm testing networks to over 670 regional on-farm trials in ESA (more than double the target of 325 trials), of which 40% are managed by female farmers.

### The capacity of African NARS and small to medium-sized seed companies strengthened

- Conducted an array of virtual capacity-building activities, including the Early Career Maize Breeders' course, which drew 305 participants (45 female, 265 male) from Africa, Asia, and Latin America.
- Established customized breeding improvement plans endorsed by respective institutional management teams for three maize breeding programs: TARI, Tanzania; ZARI, Zambia; and CRI, Ghana.
- Analyzed socio-economic data collected through regional on-farm varietal trials (ROFTs) which contributed to a greater understanding of trait preferences of stakeholders, especially women and men farmers in the target market segments.

## Wheat

### Adoption of modernized breeding approaches to deliver accelerated genetic gains.

- Leveraged nine years of international yield data to reveal annual rate gains of 2.02%, 2.83%, and 3.92% in three South Asian target population environments (TPEs).
- Developed a low-cost DArTAG single nucleotide polymorphism (SNP) genotyping platform, improving the efficiency of genomic selection while simultaneously delivering traits-associated marker data to breeders.
- Initiated an accelerated three-year breeding cycle with four bread wheat and two durum wheat breeding pipelines through product profile-based crossing in screen houses at Toluca.
- Codified enhancement of zinc (Zn) concentration in all breeding pipelines by using parents with high zinc and iron (Fe) content from extensive field phenotyping of Stage 1 and 2 yield trial lines.

### Characterization of target populations of environments to support enhanced testing networks

- Employed genomic selection and selection for agronomic, disease resistance, and grain traits, to cull 74.7% of pre-Stage 1 trial lines, which permitted expansion of grain yield testing (using an augmented, single-replicate trial design) to four selection environments in 2021-22 in Obregon, compared to only one environment of yield testing used previously.
- Expanded Stage 3 yield testing to three TPEs in four South Asian countries in the 2021-22 crop season through the extended NARS network engaging 20 partners.
- Phenotyped over 40,000 wheat breeding lines, varietal candidates, and mapping populations in Kenya, Ethiopia, Bangladesh, and Bolivia.

## Seed production of new varieties to support varietal replacement

- Implemented an approach of pre-release and early generation seed multiplication allowing partners to accelerate breeder's seed production and delivery through public and private seed enterprises.
- NARS partners in Ethiopia, Kenya, Nepal, and Bangladesh multiplied nearly 47 tons of pre-release and breeders seed of newly released varieties.
- Analysis of gender-intentional seed delivery pathways indicated farmers benefit from social networks where they have better access to information and other productive resources.
- Introgressed resistance genes into high-yielding elite breeding lines in eastern Africa and South Asia.

## Wheat rust diseases were tracked, and recommendations were developed to limit the spread of wheat disease.

- Conducted wheat rust surveillance and monitoring across large geographical areas, with a priority focus on East Africa and South Asia.
- Surveillance and early warning activities from AGG and the Wheat Rust Toolbox (GRRC, Denmark) allowed targeted chemical control to prevent an epidemic of a new rust race, *PstS16*, in Ethiopia.
- Nearly completed the new greenhouse facility at Njoro, Kenya, which will be fully functional in 2022, becoming an important resource for pathogen monitoring in East Africa.

## The capacity of NARS breeding programs strengthened in breeding and deployment of improved wheat varieties;

- Distributed elite wheat breeding lines through international trials and nurseries to over 220 NARS partners (both public and private) in 63 countries to ensure open access to CIMMYT wheat germplasm.
- NARS partners released 42 bread and 7 durum wheat varieties in 12 countries: Bolivia, Egypt, Ethiopia, India, Iran, Kenya, Nepal, Mexico, Pakistan, Tanzania, Turkey, and Zambia.
- Organized two virtual training courses in 2021. The Wheat Improvement Training Course, 25 January–28 May 2021, was attended by 68 participants including 16 women, and the Advanced Wheat Improvement Training Course, 2 August–1 October 2021, was attended by 77 scientists including 23 women from 22 countries.

For more info, please visit <https://www.cimmyt.org/projects/aqq/>