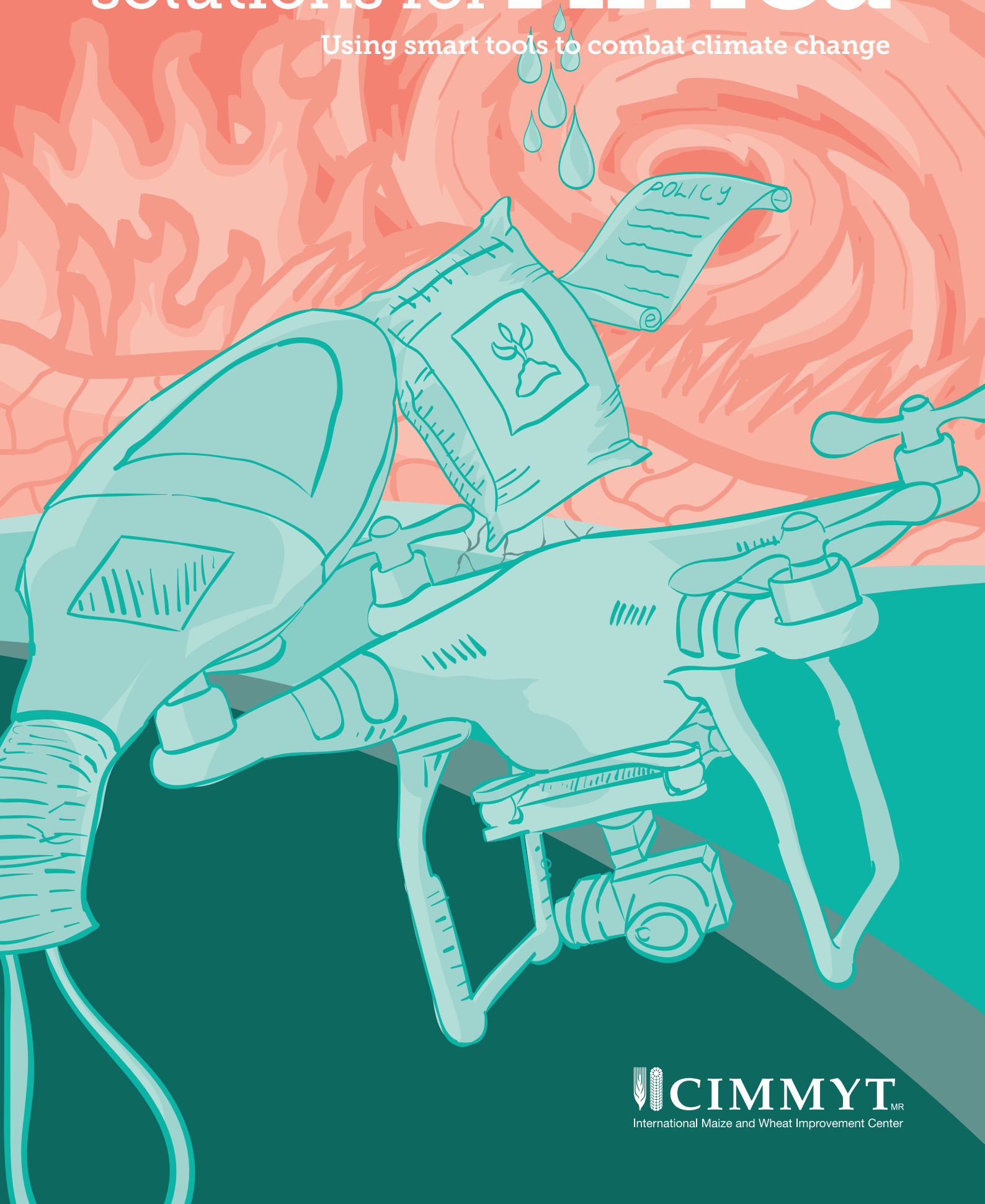# Data-driven solutions for Africa

Using smart tools to combat climate change

CONTENTS

Outlook: CIMMYT and digital agriculture in Africa

The need to improve peoples' livelihoods through maize and wheat research drives CIMMYT's work. CIMMYT researchers are pioneering the use of big data, diagnosis tools, geographic information systems, remote sensing, software, web apps and other technologies to support that mission.

Digital agriculture interventions allow CIMMYT to work faster and scale up its activities, integrate information from different areas, gain valuable insights, and develop context-specific approaches.

Maize is the most widely-grown crop in Africa, and a staple food for over 300 million people on the continent. However, climate change could put up to 40% of that growing area at risk by 2030. Meanwhile, demand for wheat is growing in sub-Saharan Africa as a result of urbanization and changing diets. The region spends more than $3.6 billion to import wheat from the volatile global market each year, when more could be grown at home.

To face these challenges, farmers in Africa need additional new tools to increase yields and bring wheat and maize to markets. CIMMYT is incorporating digital approaches throughout its work, making use of new sources of climate and geographic data, developing new tools to scale up maize and wheat breeding with partners, delivering tailored recommendations directly to farmers, training the next generation of African researchers and working with entrepreneurs to find innovative solutions.

Agriculture in Africa, even at the smallholder level, is becoming a data-driven exercise just as it has become elsewhere in the world. As digital technologies become more accessible, the data revolution will be inclusive in its drive to improve productivity and food security in African communities and cities.

The digital approaches being pioneered in CIMMYT's projects and collaborations bring solutions that better understand farmers and are helping to pave the way for the spread of data-driven agriculture in Africa.

Africa's climate is changing

Projected maize yield change to 2050

Loss — No change — Gain
-25%   -5%   +5%   +25%
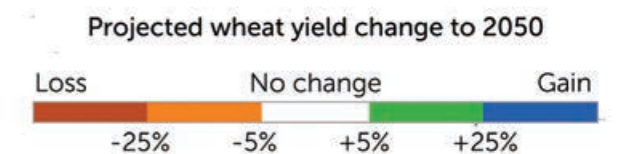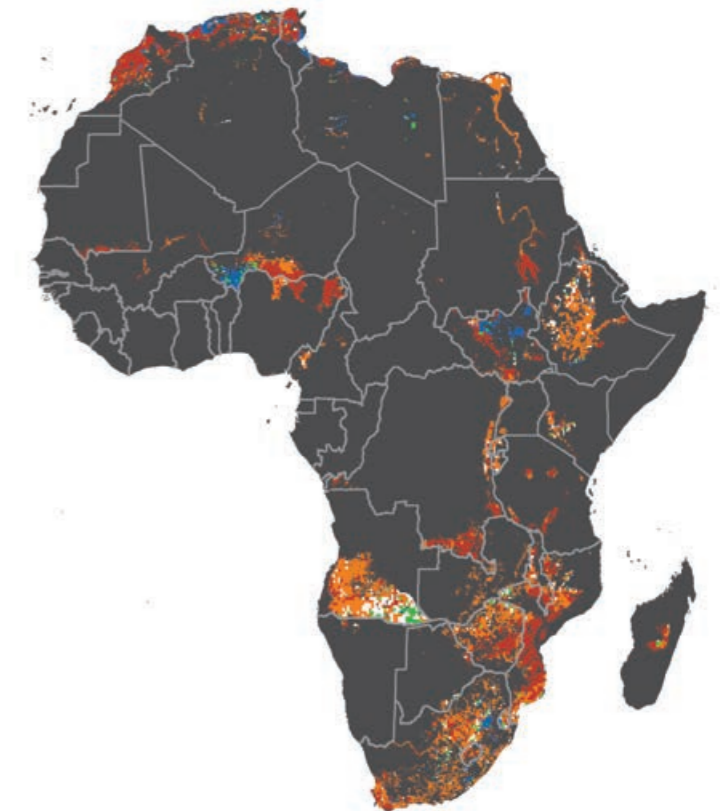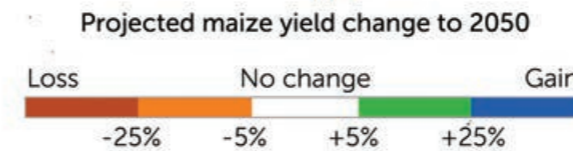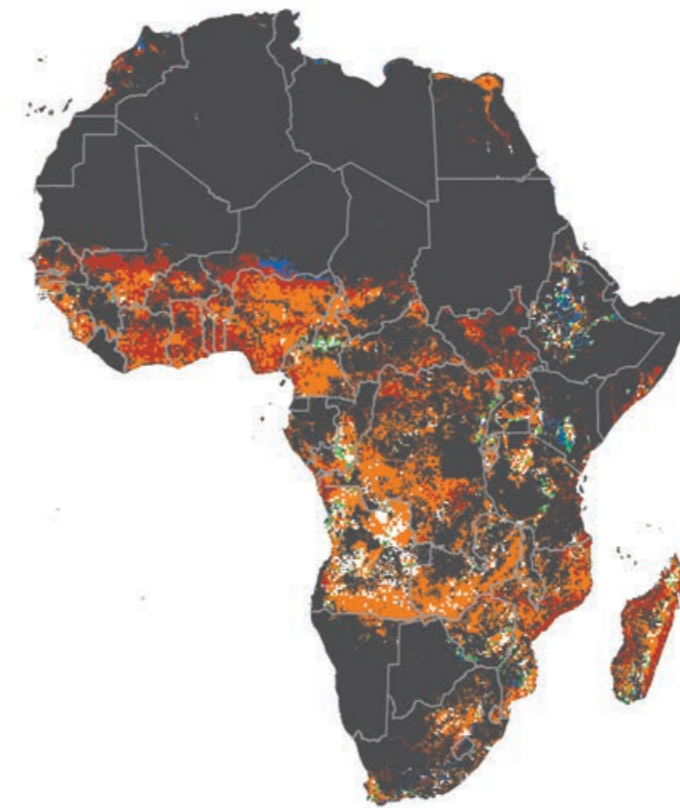
These maps are the result of a long and ongoing collaboration between IFPRI and CIMMYT on foresight work using crop modeling. The foundational research was supported by the Bill and Melinda Gates Foundation; the CGIAR Research Program on Policies, Institutions, and Markets; the CGIAR Research Program on Climate Change, Agriculture and Food Security; the CGIAR Research Program on Wheat and the CGIAR Research Program on Maize. Model outputs used for both maps by R. Robertson, IFPRI; rendering by K. Sonder, CIMMYT.

Projected wheat yield change to 2050

Loss — No change — Gain
-25%   -5%   +5%   +25%

Digital imaging tools deliver stress tolerant maize, faster and for less
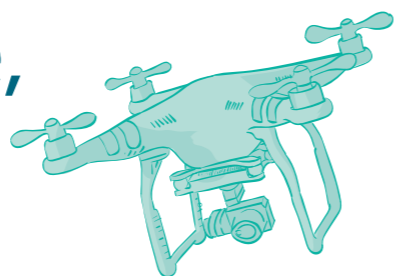
To keep up with growing maize demand, breeders optimize annual yield gain under various stress conditions, like drought or low fertility soils. To that end, they identify the genetic merit of each individual plant, so they can select the best ones for breeding.

Maize breeders use a number of different morphological indicators to understand crop performance under different environmental conditions. However, these indicators can be labor-intensive and expensive to measure.

To improve the process, researchers at CIMMYT are looking at cost-effective ways to assess a larger number of maize plants and to collect more accurate data related to key plant characteristics.

Recent innovations in digital imagery and sensors have enabled the development of high-throughput phenotyping platforms that save money and time in data collection.

Under the Stress Tolerant Maize for Africa (STMA) Project, unmanned aerial vehicles (UAVs) are used to cut the time

and cost of data collection by 25 to 75 percent compared to traditional methods.

In a ten-minute flight, a UAV can collect data from up to 1,000 plots, a process that may take up to 8 hours using manual methods.

Furthermore, the drone can collect data on several different plant traits at once, such as canopy temperature and plant count or vigor.

By adopting the latest breeding technologies, STMA and previous projects have expanded access to drought tolerant varieties to 3.5 million farmers in 13 African countries.

Thanks to the speed at which multiple stress tolerant varieties can now be released, it is even possible to grow wheat and maize in harsh areas such as southern Niger, where heat, drought and low soil fertility previously made this impossible.

Maize Ear Analyzer speeds up crop monitoring for African breeding programs

To speed up the analysis of maize cob attributes, CIMMYT has developed an inexpensive digital imaging tool called Maize Ear Analyzer that collects data up to 90% faster than traditional methods.

This tool can help breeding programs with fewer resources to improve the effectiveness of their methods, speeding up access to stress tolerant varieties.

In addition to saving time, digital methods produce more reliable data for field studies.

For example, CIMMYT has collaborated with the NGO GOAL to assess the damage caused by fall armyworm to maize crops during the 2018 cropping season in Zimbabwe.

A Tanzanian farmer holds drought tolerant maize cobs. Photo: F. Sipalla/CIMMYT.

Maize Ear Analyzer: How does it work?

1 A mounted camera is used to capture images of maize in the field

2 Images are automatically processed

3 Maize cob and kernel attributes are generated for every single image
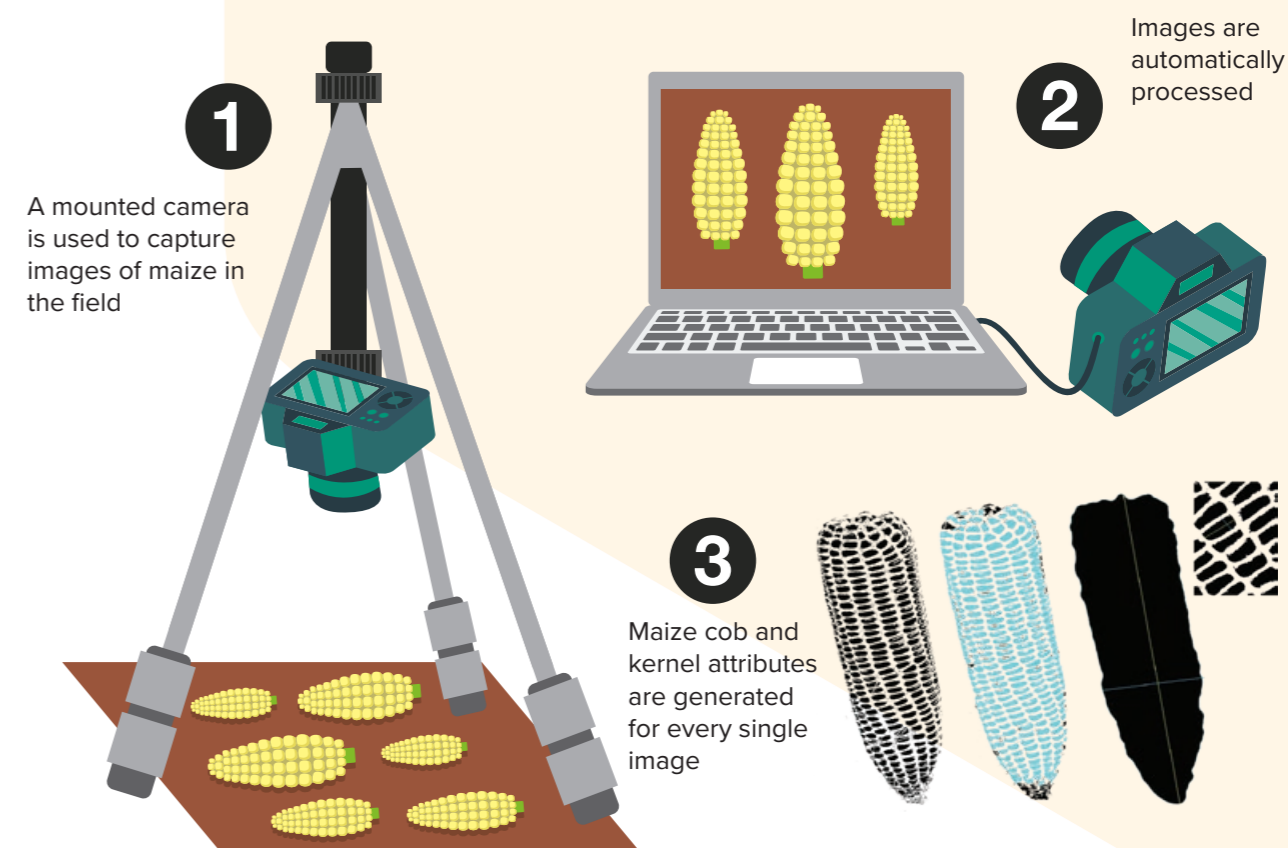
Disease tracking and response

Responding to threats requires an intelligent and coordinated response. CIMMYT uses multiple data technologies to leverage the power of science and partnerships.

Crowdsourcing, rapid diagnostics and supercomputer prediction help farmers get ahead of wheat rust

Rust diseases are one of the biggest threats to wheat production in Africa. Just one new outbreak in 2010 cut yields in half on 30% of Ethiopia's wheat growing area.

CIMMYT and the Ethiopian Institute for Agricultural Research (EIAR) have been racing to release new resistant varieties, but the disease evolves new lines of attack faster than seed systems can respond. Fungicides are the farmer's last line of defence, but stocks are limited.

In response, a coalition formed to outsmart the disease using data solutions, with a combination of crowdsourced reporting, cutting-edge labs the size of a suitcase, centralized databases and supercomputer-driven predictions delivered directly to farmer's phones.

Knowing where the risk of crop losses is greatest, the government can distribute fertilizers where they are needed, and farmers can finally get ahead of the disease.

Using mobile apps to fight fall armyworm

The fall armyworm pest has proven to be a major threat to maize production in Africa, requiring a concerted response from CIMMYT and multiple partners to spread practices to contain the disease.

CIMMYT recognized the contribution of Lokwa Mila Giresse, who received the 2019 MAIZE Innovators award for developing the Mobile Agribiz App, which applies artificial intelligence and machine learning to easily detect the pest across maize crops at any stage of the production cycle.

3. Real-time diagnostics: a mobile testing lab can identify new disease strains in 2 days

5. U.K.-based computer generates daily 7-day disease forecasts

2. Crowdsourcing: a network of 4 million farmers available to report the disease

4. Surveys and diagnostics automatically uploaded to EIAR database, linked to a global wheat rust toolbox
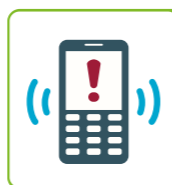
6. Reports sent to stakeholders, and targeted alerts sent to farmers at district level

1. New strain of wheat rust emerges

7. Government and farmers take action to stop disease spread

"I try to find where to apply my computer science skills to solve the most crucial problems affecting our world today."

Lokwa Mila Giresse
founder of Mobile Agribiz

Bringing the data revolution to smallholder farmers

What fertilizer applications will give me the best returns? What maize crop variety should I use? Farmers need agronomic advice about such decisions as fertilizer and crop variety, tailored to their preferences and site-specific production conditions.

Too often, farmers can only rely on national-level recommendations that are not optimal for their fields and/or their personal economic circumstances. The fast-evolving world of sensors and communication technologies, modern analytics and big data from satellites and other sources offers new opportunities to deliver precision agriculture to the African smallholder farmers.

CIMMYT has been working on understanding and articulating how new approaches to smallholder-oriented agronomy can take advantage of new tools, platforms and data sources.

Site-specific agronomic recommendations at scale

The TAMASA (Taking Maize Agronomy to Scale in Africa) collaborative project has gained valuable insights on scalable approaches that help maximize farmers' returns on their investments by providing farmers with timely, accurate, and site-specific advice on locally available crop varieties, fertilizer and complementary agronomic practices.

As part of the project, site-specific advisory tools have been developed and tested with local partners in Ethiopia, Kenya, Nigeria and Tanzania. These mobile applications include:

Nutrient management: Fertilizer application rates and complementary practices are generated for site-specific maize growing conditions.

Seed variety selection: Geo-referencing enables the user to locate their field, choose sowing and harvest dates, and receive a recommendation about the best maize variety to use.

Seeding rate advisor: Provides guidance on how much seed to buy depending on the variety chosen and how best to plant it. The app can measure field dimensions, decide optimum plant density and calculate seed needed for different varieties.

Studies in Nigeria and Ethiopia show farmers are more likely to invest when they have access to tailored advice. Ongoing research is tackling how to better design and scale up investments in digital advisory services.

Better frameworks for targeting investments

TAMASA is also developing scalable geospatial decision support frameworks for predictive agronomy, which use geographic data to target agricultural interventions to where they are most likely to pay off. Examples include mapping the likely farmgate prices for inputs like fertilizer and maize grain, and linking this to models that show the potential for fertilizer recommendations to improve farm profitability. One application is to advise large-scale agronomic programmes on optimal input recommendations for particular areas of interest, as well as targeting the areas where farmers are most likely to adopt new technologies.
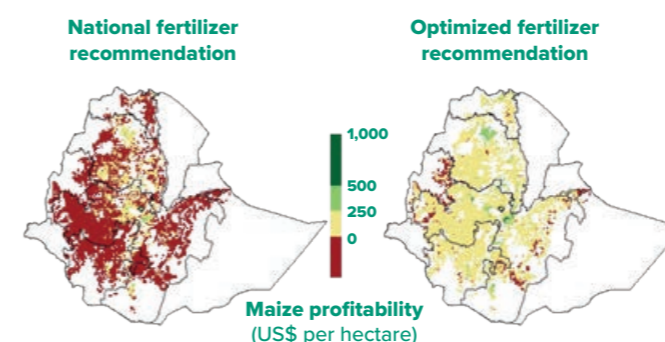
Collaborative frameworks for sharing and scaling agronomic research

Traditional data collection and research analysis methods are often ad hoc and difficult to replicate at scale. TAMASA is developing a digital handbook to reform the practice of agronomy@scale in partnership with the Geospatial and Farming Systems Research Consortium at the University of California, Davis. The handbook contains open-source programming workflows and publicly-accessible data, for use by agricultural researchers, university instructors and other actors in national and international research systems. Rethinking agronomic research in a digital and collaborative way will lower the costs of generating compatible datasets and make research more reproducible and scalable.

National fertilizer recommendation

Optimized fertilizer recommendation

1,000

500

250

0

Maize profitability
(US$ per hectare)

Making use of digitized genetic diversity

CIMMYT manages humankind's most diverse maize and wheat collections. This remarkable, living catalog of genetic diversity comprises of over 28,000 unique seed collections of maize and 150,000 of wheat.

To support our mission of preserving and sharing the wealth of genetic variety in its maize and wheat collection, CIMMYT is working hard to digitize this information to share in public databases for agricultural researchers to access.

Finding the pieces of the puzzle

Among the huge collection of data on maize and wheat genetic resources lie valuable genes that will form the basis of new varieties to improve food security and livelihoods.

The Genetic Analysis Service for Agriculture, for example, provides unique insights from genomic information related to field performance.

"Currently only five to eight percent of materials in the germplasm bank are being used by breeding programs. The global diversity analysis could have huge impacts on the future of wheat yields."

Carolina Sansaloni
CIMMYT High-throughput genotyping and sequencing specialist

"Because our results are freely available, they ... can accelerate genomics-assisted breeding for this crucial food crop."

Philomin Juliana
CIMMYT wheat breeder

The wheat reference genome: a map to better varieties

In 2018, researchers were finally able to publish a full reference genome for wheat, which is five times the size of that of a human.

CIMMYT wheat breeder Philomin Juliana, is working with a CIMMYT team to identify where the high-performing genes identified by CIMMYT are located on the reference genome, allowing breeders to more precisely select for these qualities when developing new varieties.

"Because our results are freely available, they represent a valuable resource for the global wheat research community and can accelerate genomics-assisted breeding for this crucial food crop," said CIMMYT wheat breeder Philomin Juliana.

Genotyping

CIMMYT has characterized 99% of maize and 45% of wheat samples in its germplasm collection, creating a partial "fingerprint" for each.

Databases

All the data collected on maize and wheat collection, including useful genes, field performance, passport and other descriptive data is uploaded in an online database known as Germinate, where members of the public can access and even visualize the data.

Going global

CIMMYT is connected to the global germplasm bank databases GRIN-Global and Genesys, which document collections from genebanks all around the world in one single place, to facilitate sharing.

Atlases

Researchers, extension workers and farmers need different varieties to meet the particular challenges they face. Databases and tools form "atlases" to assist researchers to identify samples in the germplasm bank that are likely to contribute valuable traits to breeding programs for different environments.

Bringing forensic analysis to farmer's fields

DNA fingerprinting is a technique used to identify individuals based on their genetic makeup. CIMMYT is using new low-cost platforms to track which varieties are being grown in farmer's fields, to see who is benefiting from modern varieties and where resistance to crop diseases is greatest.

The first national DNA fingerprinting survey of wheat varieties grown by farmers took place in Ethiopia over 2016-2017. It was found that while farmers were often unsure which varieties they were growing, 87% of the area surveyed was sown with varieties developed or derived from CIMMYT materials. It also showed that new wheat varieties were being rapidly adopted, including those resistant to wheat rust disease.

Compared to farmer surveys and expert opinion, DNA fingerprinting has proven to be far more accurate at tracking variety adoption, while being available at a low cost and large scale.

Farmer Gashu Lema harvests wheat variety "Kubsa" in Gadulla village, Mojo, Ethiopia.

Market data drives variety development

Improved varieties are one of the most important tools to improve the productivity, resilience and profitability of smallholder farming, raise nutrition and adapt to climate change. But how can it be ensured that farmers actually grow them?

The answer is to adopt a demand-led approach to breeding that combines data from many sources, including industry and farmer representatives, to guide crop breeders to create varieties that the market needs.

Using product profiles to guide breeding decisions

As part of the modern approach to breeding, CGIAR research centers are beginning to employ product managers to coordinate the development of new varieties in collaboration with key stakeholders.

Tawanda Mashonganyika is one of the first to occupy this role, working with the CGIAR Excellence in Breeding Platform (EiB), led by CIMMYT, to help spread best practices among CGIAR and national agricultural research institutions working in Africa.

One of the key tools in this area is the concept of a product profile: a written description of a new product with all the traits needed to replace the variety that currently dominates the target market.

The product profile is used to capture input from breeders, socio-economists, gender and market specialists, seed producers in farmers in a description of new varieties that can be released that are certain to be popular with farmers.

Captured in an online tool, the product profile serves as a guide for CGIAR and NARS crop breeding collaborations, while the database will support decision-makers and donors to identify where new varieties are being developed, and what support is needed.

**The online tool can be accessed at:**
http://bit.ly/eib_toolbox

An Africa-wide database of target markets and varieties to be delivered for farmers

EiB is working with CGIAR and NARS to define target markets for the different crops important to Africa, and then to document the different products being worked on for farmers in these areas. To date, 250 different varieties have been identified across CGIAR and NARS partners, including around 40 maize and 40 wheat varieties. When the database is complete, it will be possible for the first time to visualize public sector crop breeding goals in Africa.

"You need to know who you are developing varieties for, who are your customers and clients, and you also need to design products so that they can have success on the market."

Tawanda Mashonganyika
EiB product manager
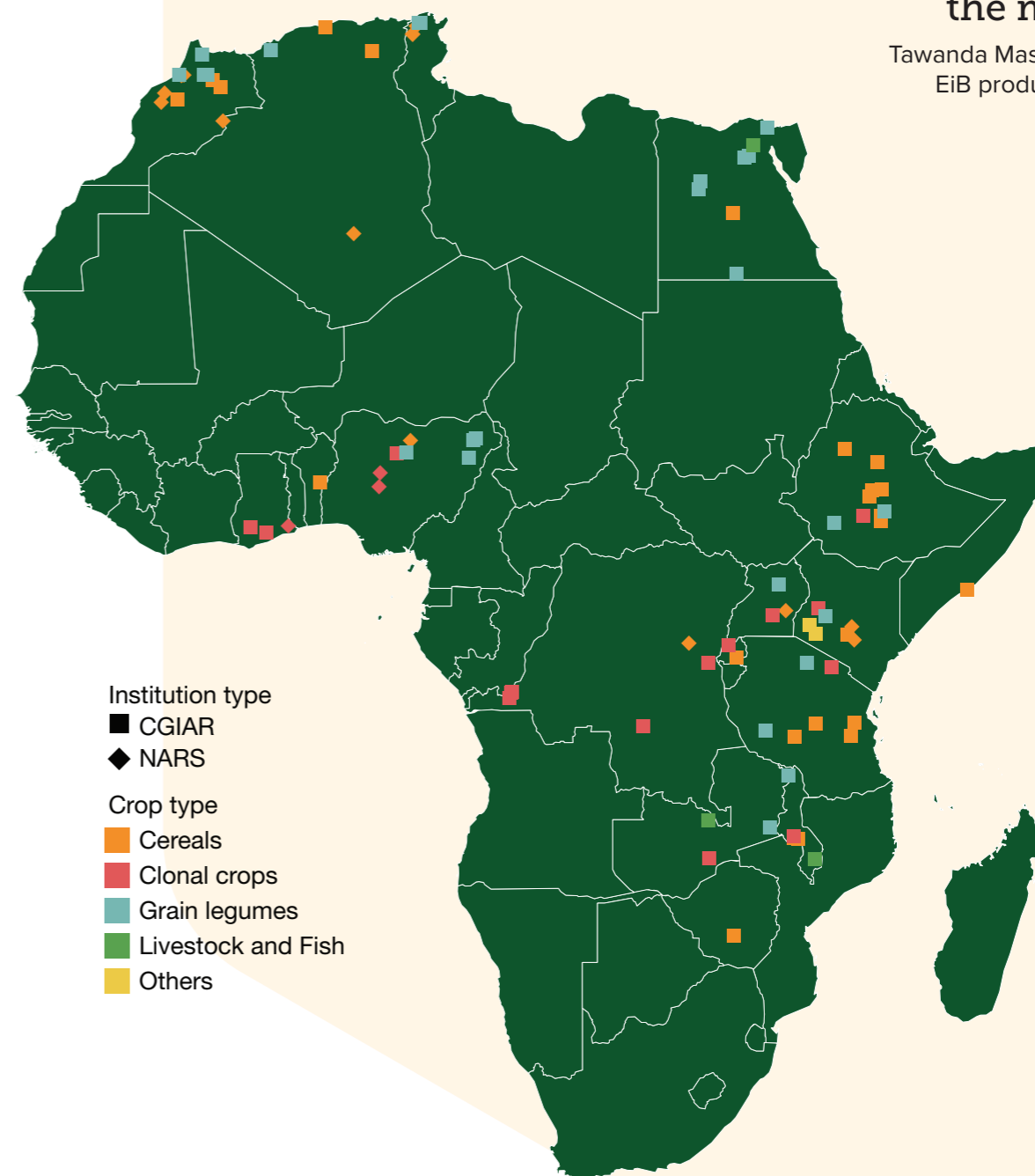
The CGIAR Excellence in Breeding Platform provides access to cutting-edge tools, services and best practices, application-oriented training and practical advice to modernize breeding programs targeting the developing world.

Product design and management

Optimizing breeding schemes

Bioinformatics, biometrics and data management tools and services

Excellence in Breeding
PLATFORM

Genotyping/ sequencing tools and services

Phenotyping tools and services

Institution type
- CGIAR
- NARS

Crop type
- Cereals
- Clonal crops
- Grain legumes
- Livestock and Fish
- Others

Inclusive agriculture

GENNOVATE
ENABLING GENDER EQUALITY
IN AGRICULTURAL AND
ENVIRONMENTAL INNOVATION

"These tools and guides address the role of gender norms in relation to a variety of topics from climate-smart agriculture, mechanization and nutrition to local poverty dynamics and agency."

Lone Badstue
Gennovate Project leader

The GENNOVATE project

A food-secure future must also be an inclusive one, where agricultural innovations are targeted at all those involved in farming, from the women and men who undertake farming tasks, to household decision-makers and the next generation.

It is a challenge for agricultural researchers to address gender in their work, but now it is possible to draw on tools derived from a huge codified database of interviews with women and men: a total of 7,500 participants from 137 communities in 26 countries (over half in Africa).

Farmers test tractors during a field day in Zimbabwe.

GENNOVATE is a global comparative research initiative that addresses the question of how gender norms and agency shape who can – and who cannot – learn about, try out and take up innovation in agriculture and natural resource management.

The project has produced tools and guides that give evidence about gender norms in agriculture, challenge assumptions and provide gender-inclusive data collection instruments that are easily accessible to researchers.

"These tools and guides address the role of gender norms in relation to a variety of topics from climate-smart agriculture, mechanization and nutrition to local poverty dynamics and agency. The resources are developed specifically for agricultural researchers and practitioners to help them think gender into their work," said Lone Badstue, Gennovate Project leader.
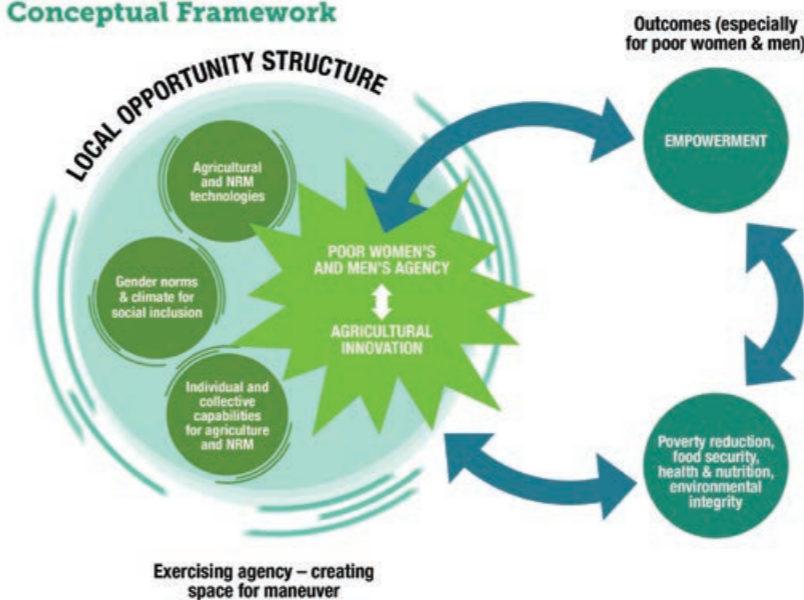
One of the key findings of the study was the role of women innovators, identified by members of their community as being known for trying new things. A disproportionate number of these women were the head of their household: these women heads of households may be key to strengthening agricultural innovations at a local level, by providing role models to change normative contexts.

In sub-Saharan Africa, a quarter of households are now headed by women, and a World Bank study suggests that these households are generally experiencing higher rates of poverty alleviation.

Gender tools and resources for agricultural researchers can be found at: http://bit.ly/gendertools

GENNOVATE
Conceptual Framework

LOCAL OPPORTUNITY STRUCTURE

Agricultural and NRM technologies

Gender norms & climate for social inclusion

Individual and collective capabilities for agriculture and NRM

POOR WOMEN'S AND MEN'S AGENCY

AGRICULTURAL INNOVATION

Outcomes (especially for poor women & men)

EMPOWERMENT

Poverty reduction, food security, health & nutrition, environmental integrity

Exercising agency – creating space for maneuver

Selected tools:

- **Ladder of Life**: Qualitative data collection tool to understand local perceptions of poverty dynamics
- **Using vignettes to explore gender dimensions** of household food security and nutrition
- **Enhancing the gender-responsiveness** of your project's technical farmer training events
- **Entry points for enabling gender equality** in agricultural and environmental innovation
- **Gender in agricultural mechanization**: Key guiding questions
- **Continuity and change**: Negotiating gender norms in agricultural research for development in Rwanda.
- **Towards gender-responsive banana research** for development in the East-African Highlands
- **Embedding gender in Conservation Agriculture** R4D in sub-Saharan Africa

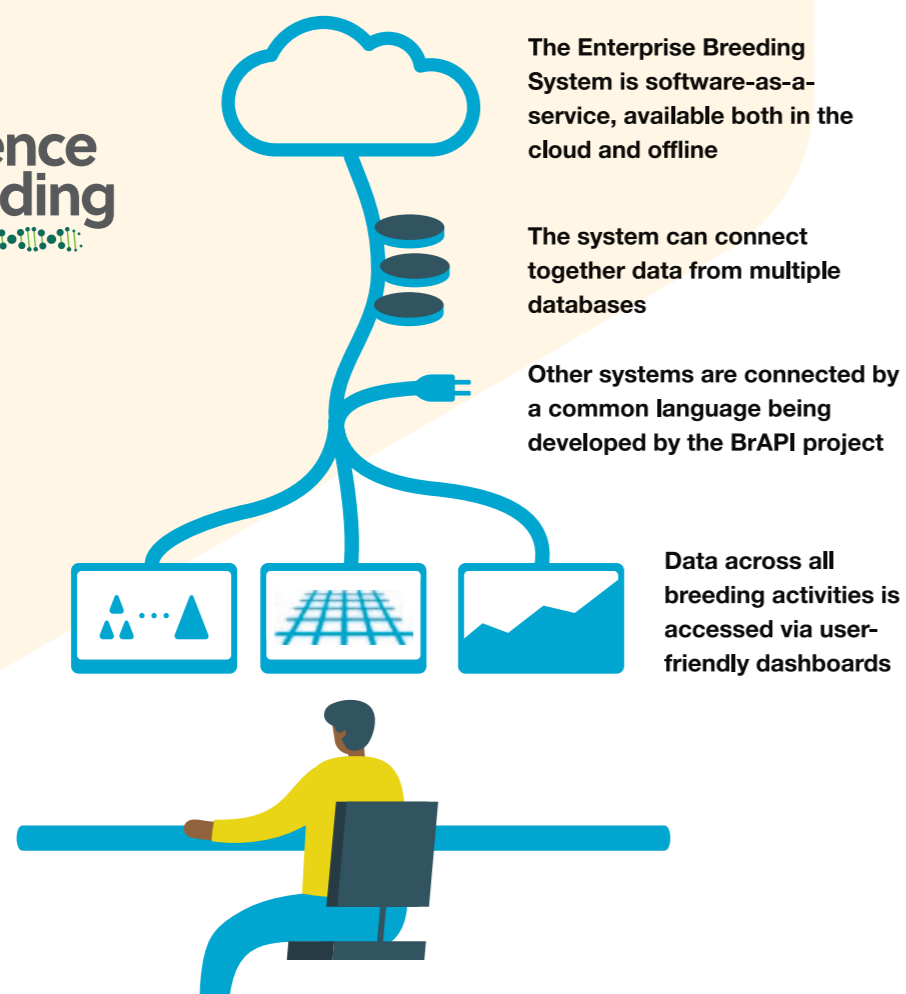# New software to manage the data revolution in breeding

Thanks to the data revolution in genomics and crop measurement, it is now possible to improve varieties much faster, to keep up with demand and challenges such as climate change. The sheer quantity of data available also adds more complexity, meaning that breeders have turned into data managers as they attempt to keep up with new technologies.

In response, the Excellence in Breeding Platform has established a software development team at CIMMYT headquarters to create a cloud-based system to manage the entire breeding process, from defining breeding goals, to creating experiments, collecting data, connecting different databases and analytics tools, and finally enabling breeders to make data-driven decisions.

As a result, breeders will be able to focus on what they do best, leveraging the latest technologies to deliver improved varieties to farmers.

The Enterprise Breeding System (EBS) is being codeveloped with the CIMMYT wheat and maize programs, as well as the International Rice Research Institute. As more functionalities are made available, the system will be tested and expanded to more breeding organizations, including NARS in Africa.

The system is based on a modern software-as-a-service model, where it can be used both offline and online, with all updates made from a central server to minimize the need for IT expertize and investment to adopt and maintain the system.

Excellence in Breeding
PLATFORM

The Enterprise Breeding System is software-as-a-service, available both in the cloud and offline

The system can connect together data from multiple databases

Other systems are connected by a common language being developed by the BrAPI project

Data across all breeding activities is accessed via user-friendly dashboards

Breeding API

There are many different tools available to collect, manage and analyze breeding data, so much so that it becomes a major task just to share data.

The Breeding API (BrAPI) is an approach to resolving this dilemma by creating a common language for applications to share data. This allows breeders to connect supported applications, most of which are open-source, in to their breeding procedures.

Supported by both CIMMYT and the Excellence in Breeding Platform, BrAPI is being developed by a team of programmers around the world, who come together in hackathons to fast-track the addition of new features and compatibilities.

The High-throughput Genotyping project

The cost of genotyping services has fallen rapidly in recent years, but many smaller breeding programs in Africa do not genotype in enough volume to take advantage of low prices, or possess the know-how to make best use of genomic information to improve crops faster.

The high-throughput genotyping project (HTPG) aggregates demand for genotyping services from smaller breeding so that they can negotiate the same prices enjoyed by multi-national companies, providing training and workshops in the use of genotypic data in breeding programs.

The Integrated Breeding Platform

The Integrated Breeding Platform (IBP) is a not-for-profit entity with the mission to help breeders accelerate the delivery of new crop varieties to smallholder farmers, especially in developing countries. It does so by providing them IT tools, crop breeding services and training, so that they may fully join in the global effort towards achieving food security. Access to the right tools and opportunities will help breeders achieve more efficiency in crop improvement, and therefore have a concrete impact on their specific local environments.

IBP has a proven track record in working with plant breeders around the world, from emerging national programs to small-and-medium enterprises, to facilitate technology adoption and digitalize their breeding practices. Its core product, BMS Pro, will be a compatible component of the Enterprise Breeding System (EBS), currently being developed by the CGIAR Excellence in Breeding Platform (EiB), with the interoperability between systems being enabled through the Breeding Application Programming Interface (BrAPI).

Its core product, BMS Pro, will be a compatible component of the Enterprise Breeding System currently being developed by EiB, with the interoperability between systems being enabled through BrAPI.

The GeoData revolution

Advances in recent years mean that researchers, extensionists and farmers in Africa have the possibility to benefit from a rich spectrum of geospatial data, with new climate, soil and population data now available at smaller scales, higher update frequencies and lower costs.

In a region threatened by climate change and already strongly affected by climate variability including frequent droughts, floodings and other extremes, the Geographic Information Systems (GIS) unit at CIMMYT works with projects to better target their interventions and predict future needs and trends.

The unit collects, curates and continuously updates a comprehensive collection of geospatial datasets and geographic databases for all maize- and wheat-producing countries in the developing world.

By combining these different datasets, it is possible to visualize farming outcomes at the micro-level, but also at scale, making it possible to map the potential for new varieties or agricultural technologies, or to gauge the market potential for the small- and medium-scale seed companies working with CIMMYT.

One project with the BioSense Institute in Serbia combines machine learning expertize with CIMMYT's plot level data from thousands of farmer's fields growing maize in Mexico and data on new maize varieties developed with a number of small- to medium-sized seed companies. The goal is to help farmers to purchase those varieties that have the highest potential for their respective local climate and soil conditions.

Predicting long term future trends takes place by analysing, mapping and modelling climate change implications, crop suitability, socioeconomic and other data sets affecting agricultural production across the globe.

Game changing data

We are currently entering into what is being called the fourth agricultural revolution, with widening access to game changing data and information sets in addition to novel data analytics including use of machine learning and AI, advanced sensing equipment and precision agriculture.

CIMMYT is working within the CGIAR Platform for Big Data in Agriculture, and with partners both old and new to leverage these technologies to provide a better base for decisionmaking to resource constrained farmers and help them to sustainably increase production.

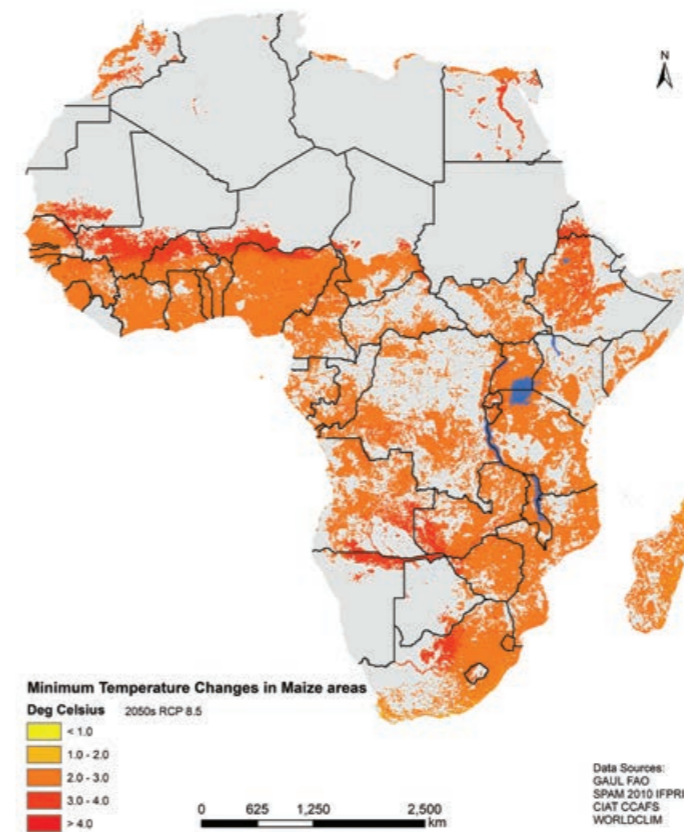## The potential for climate-resilient maize in Africa

In many areas of sub-Saharan Africa, climate is responsible for over half the variation in maize yields, and climate change will only exacerbate these effects. However, it is possible for farmers to adapt by adopting stress-tolerant varieties with higher yields, both in good conditions and under drought or heat stress. Researchers at CIMMYT are facing the climate challenge by broadening their testing network for new varieties, incorporating molecular markers into variety selection, improving experimental design and facilities in Africa, and strengthening seed systems.

As a result of this effort, over 3.5 million farmers in Africa are now growing stress-tolerant maize varieties.
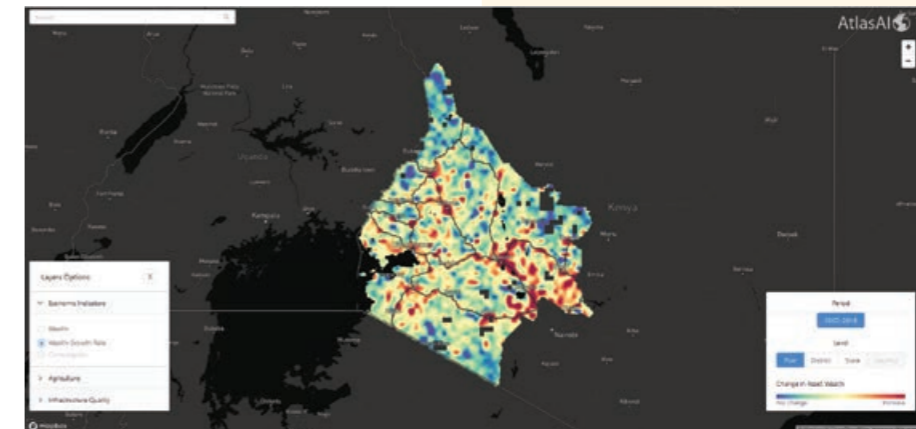
In trials, the new varieties have been shown to yield 20-25% more than current commercial varieties under low-input and drought stress conditions, while crop modelling shows the potential yield advantage of adoption is between 5-25% in the region. Moreover, during the severe El Niño-induced drought and heatwave in the 2015-2016 cropping season, the improved varieties achieved twice the yield in on-farm trials.
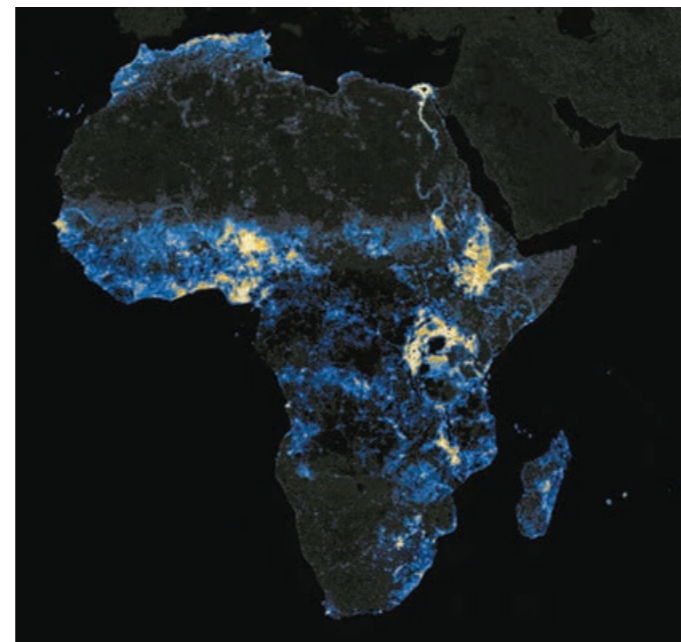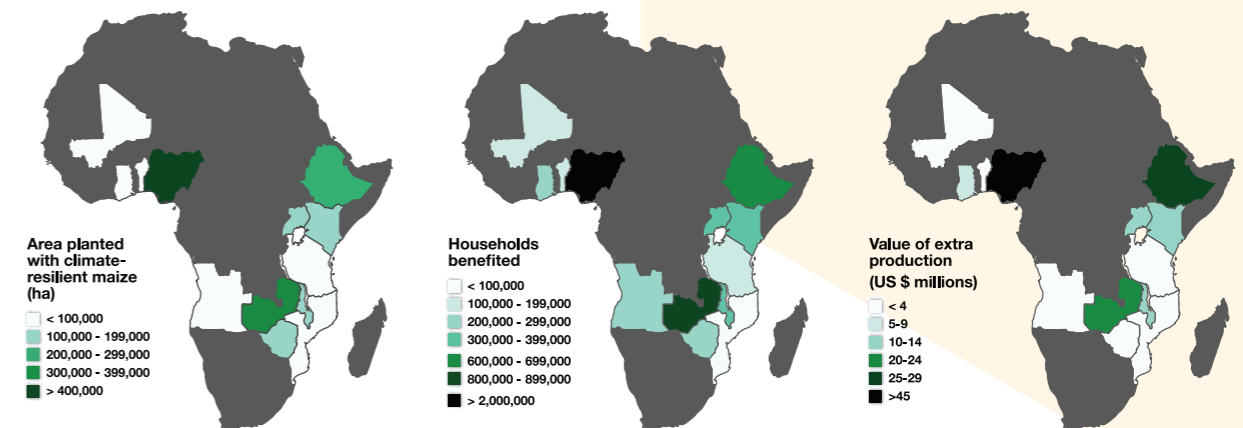

High resolution population data is now available. For example, Facebook combines satellite images with machine learning and census data. (AI.Facebook.com).

Minimum Temperature Changes in Maize areas
Deg Celsius   2050s RCP 8.5

- < 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- > 4.0

Data Sources:
GAUL FAO
SPAM 2010 IFPRI
CIAT CCAFS
WORLDCLIM

0   625   1,250   2,500 km

By combining data sources it is possible to predict local temperature changes under different climate change scenarios.

"Through crop modelling we have been developing better physiological understanding of Genotype x Environment x Management interactions, optimizing crop management systems and exploring cropping system options in variable environments using long-term weather data."

Martin Kropff
CIMMYT Director General

AtlasAI combines geospatial and ground-truth with machine learning to show economic trends at high resolution. (AtlasAI.co).

Area planted with climate-resilient maize (ha)
- < 100,000
- 100,000 - 199,000
- 200,000 - 299,000
- 300,000 - 399,000
- > 400,000

Households benefited
- < 100,000
- 100,000 - 199,000
- 200,000 - 299,000
- 300,000 - 399,000
- 600,000 - 699,000
- 800,000 - 899,000
- > 2,000,000

Value of extra production (US $ millions)
- < 4
- 5-9
- 10-14
- 20-24
- 25-29
- >45

Adapted from: Jill Cairns and BM Prasanna, Developing and deploying climate-resilient maize varieties in the developing world. Current Opinion in Plant Biology (https://bit.ly/2IEIXyQ).

Online capacity development

Networking and cooperation:

Through the alumni platform, CIMMYT maintains contact with over 1,000 alumni who act as CIMMYT's ambassadors in 26 African countries and regions.

The CIMMYT Academy was launched in February 2018, bringing all CIMMYT's capacity development and training activities under one umbrella.

The goal of CIMMYT's advanced digital training platform – academy.cimmyt.org – is to enhance the diverse forms of learning that take place across CIMMYT and with partners, including online trainings from external services. The digital platform also serves to enhance knowledge management and sharing, as well as to foster communities of practice, therefore enhancing productivity and impact in agricultural research for development.

Expected outcomes include a stronger global network of partners, research and development institutions and universities to foster a new generation of scientists and researchers who directly contribute to the research productivity in CIMMYT and in their home countries.

More than 1,000 applicants for student research and training courses from 26 African countries have shown interest and many applied successfully for CIMMYT training courses and research topics at our headqurters in Mexico or in one of our 11 regional offices – three located in Kenya, Ethiopia and Zimbabwe.

	COUNTRY	USERS
	Kenya	373
	Ethiopia	185
	Zimbabwe	94
	Nigeria	61
	South Africa	55
	Egypt	48
	Morocco	41
	Zambia	38
	Tunisia	32
	Uganda	30
	Tanzania	19
	Malawi	17
	Rwanda	11
	Ghana	9
	Benin	8
	Mali	7
	Côte d'Ivoire	6
	Cameroon	5
	Mauritius	4
	Namibia	4
	Sudan	4
	Burkina Faso	3
	Madagascar	3
	Swaziland	3
	Angola	2
	Botswana	2

CIMMYT and CGIAR

With Big Data approaches now a reality, the volume, variety and velocity of data coming into CIMMYT's research programs have reached unprecedented levels.

The challenge is to store, curate, transfer, visualize and analyze the enormous datasets generated by activities such as high-throughput genotyping and phenotyping, remote sensing and geo- informatics, so these data can be made available as public goods. This also means finding ways to deliver real-time data as valuable information to smallholder farmers, making them key beneficiaries of the data revolution in agriculture.

Our aim is to harness Big Data for greater research impact. What matters is not just the amount of data we compile, but the purposes they serve, such as helping CIMMYT breeders accelerate genetic gains and get improved varieties to farmers more quickly, or gaining a better understanding of technology adoption through the analysis of gender-disaggregated data.

As lead center for the CGIAR Excellence in Breeding Platform, CIMMYT is working with other centers to develop the Platform, establish data management processes and deploy software tools that enable breeders to make better decisions.

As an active participant in the CGIAR Big Data platform, CIMMYT works on Big Data science and helps to achieve compliance with common data standards, platforms and processes.

2018: Machine Learning for smarter seed collection

Using machine learning, researchers can predict both yields and risks associated with different seeds at a specific farm and select a mixture of varieties that represents the optimal trade-off. Using data from hundreds of on-farm and experimental CIMMYT sites, as well as a network of seed companies producing varieties for diverse agro-ecologies, partner BioSense is developing machine learning models that predict the performance of seed varieties in particular conditions in order to advise maize farmers in Mexico on what to plant.

"As an active participant in CGIAR Big Data Platform communities of practice, CIMMYT is a key partner in developing and advocating data-driven approaches to agricultural research, having received two Inspire Challenge awards and funding for various projects. The Platform also supports the development of the CIMMYT digital transformation strategy, which will help keep CIMMYT at the forefront of the digital revolution in agriculture and research for development..."

Brian King
Coordinator, CGIAR Platform for Big Data
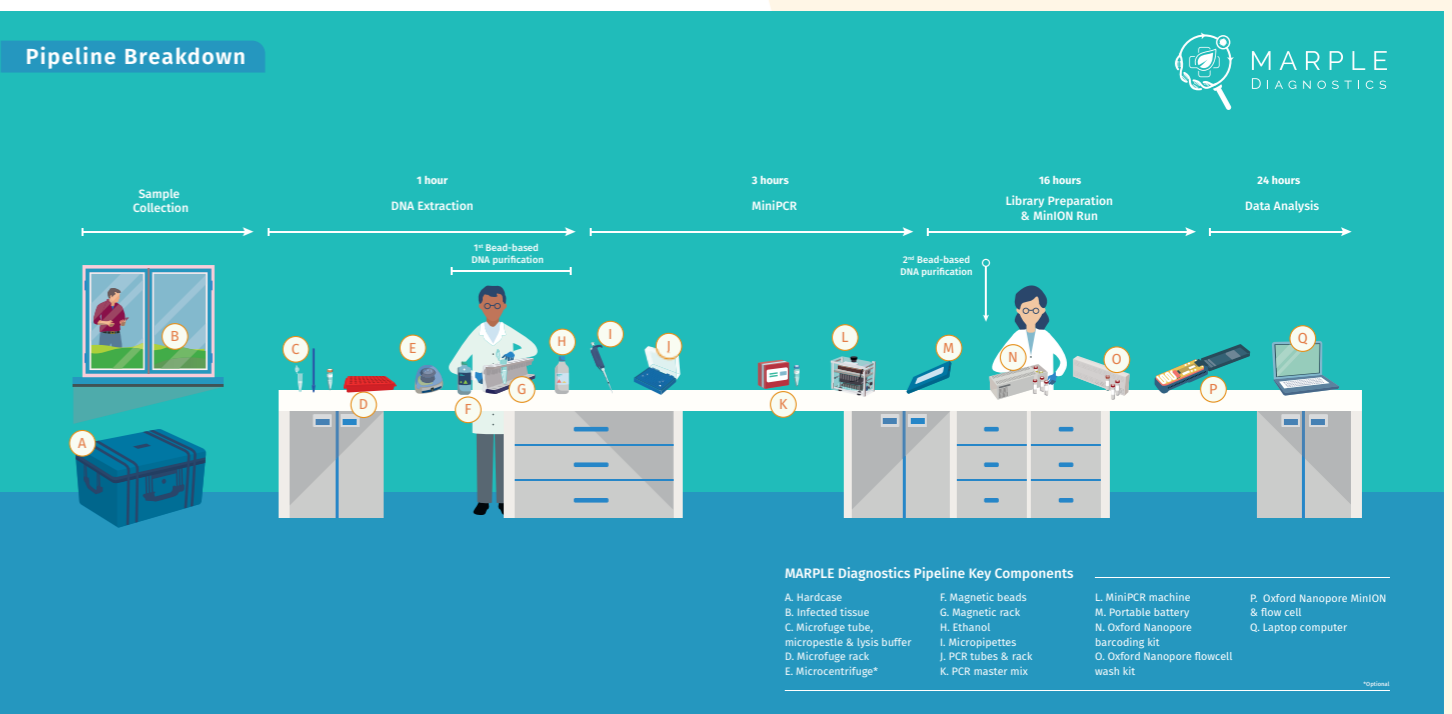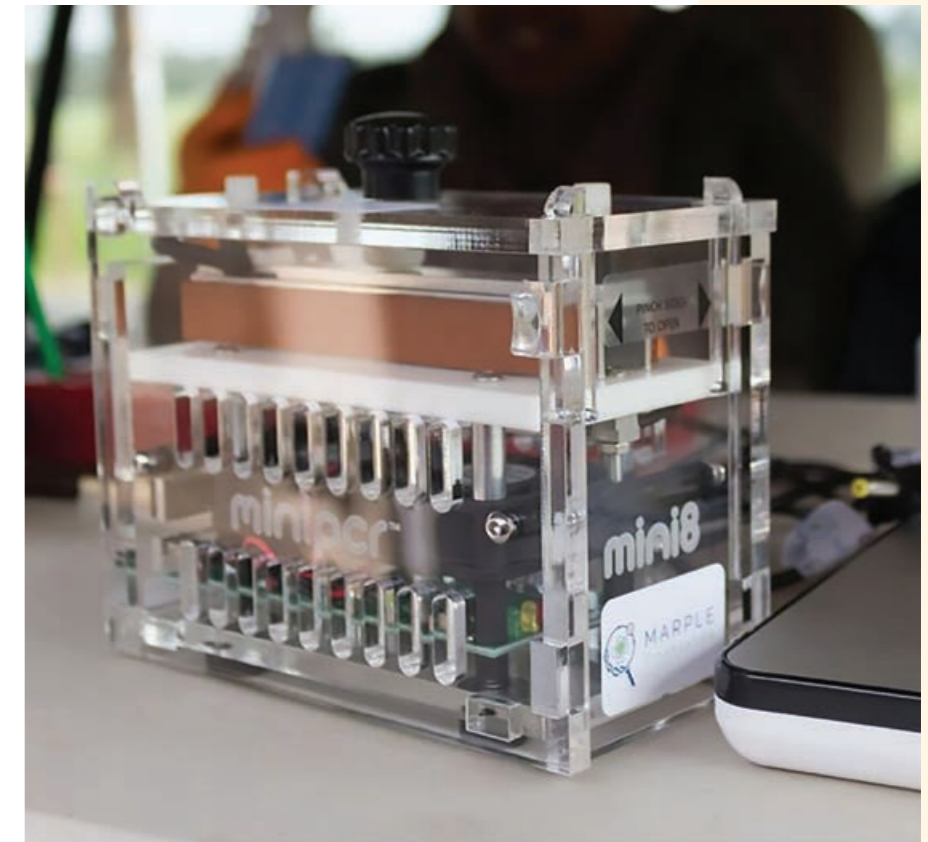in Agriculture

Inspire Challenge

The CGIAR Big Data Platform Inspire Challenge is an initiative to challenge partners, universities, and others to use CGIAR data to create innovative pilot projects that will scale.

In both years of the challenge, CIMMYT teams have emerged among the five announced winners.

2017: Real-time diagnostics for devastating wheat rust

This project with the John Innes Center, U.K. and the Ethiopian Institute of Agricultural Research is developing and mainstreaming an affordable, mobile in-field pathogenomics platform called MARPLE (**M**obile **A**nd **R**eal-time **PL**ant dis**E**ase) diagnostics that will revolutionize crop pathogen surveillance and diagnostic. Through quicker, cheaper, and readily deployable software and data management tools, MARPLE diagnostics seeks to reduce wheat yellow rust risks for smallholder farmers.

Pipeline Breakdown

MARPLE Diagnostics Pipeline Key Components

A. Hardcase
B. Infected tissue
C. Microfuge tube, micropestle & lysis buffer
D. Microfuge rack
E. Microcentrifuge*

F. Magnetic beads
G. Magnetic rack
H. Ethanol
I. Micropipettes
J. PCR tubes & rack
K. PCR master mix

L. MiniPCR machine
M. Portable battery
N. Oxford Nanopore barcoding kit
O. Oxford Nanopore flowcell wash kit

P. Oxford Nanopore MinION & flow cell
Q. Laptop computer

Leaf samples are taken in the field.

Samples are tested in the field using mobile equipment.
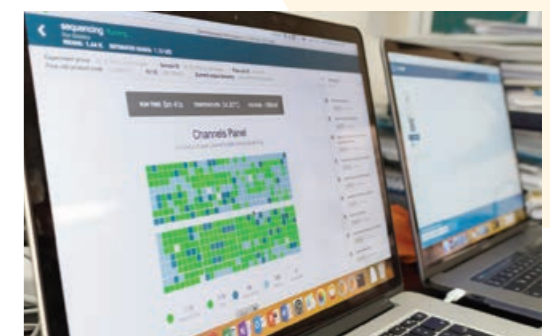
Laptop computers in the lab display sequencing results.

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CIMMYTMR
International Maize and Wheat Improvement Center

CGIAR

CIMMYT – the International Maize and Wheat Improvement Center – is the global leader in publicly funded maize and wheat research and related farming systems. Headquartered near Mexico City, CIMMYT works with hundreds of partners throughout the developing world to sustainably increase the productivity of maize and wheat cropping systems, thus improving global food security and reducing poverty. CIMMYT is a member of CGIAR and leads the CGIAR Research Programs on Maize and Wheat and the Excellence in Breeding Platform. The Center receives support from national governments, foundations, development banks and other public and private agencies.

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