EVOLVE

ICRISAT Annual Report 2019

In Focus: Special lift out on Modernizing Breeding

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Front Cover: Photo: *S Punna, ICRISAT*

Photo: Liam Wright, ICRISAT

Message from the **Board Chair**

Given our ever-changing global needs, ICRISAT continues to work along value chains of its mandate crops. Team ICRISAT and its partners are ever eager to constantly improve in breeding climate-proof nutritious crops that contributes to wellbeing in the drylands.

I am pleased to see that our valuable partnerships in the various sectors accomplished many a milestone in the year. We have launched the world's first fully automated system for plot monitoring called agCelerant that provides climate solutions for Nigerian Agriculture. In Asia, crop cycle was reduced by half in semi-controlled greenhouse conditions through rapid generation advancement of chickpea. In Eastern and Southern Africa, the Malawi Seed Industry Development Project recorded significant impacts through nutrition-sensitive multi-sectoral interventions. We have set up advanced regional breeding hubs in India, Mali and Zimbabwe. We are focused on operating efficient and agile breeding programs with the use of modern technology. Thanks to all our partners for making this happen.

Positively looking at the future of ICRISAT and the CGIAR, we are hopeful and enthusiastic about the aspiration of the system to enhance the focus and re-liven the impact of research. We are keen to contribute and collaborate with our stakeholders to make consistent greater impact in the drylands.

The Governing Board of ICRISAT reiterates its commitment to responsible governance from policy making to implementation to deliver our mission.

Dr Paco Sereme
ICRISAT Governing Board Chair

Message from the **Former Director General**

I have faith in investment in agriculture research leading to some optimism as we look forward to the next part of the 21st century. ICRISAT for 48 years has delivered varieties and hybrids to farmers and seed companies with great success, but we cannot continue to operate as we have.

In 2019, we launched our modernization program and crop improvement supported by key donors. Product profiles are key to all our crops, defining what the market wants and that defines the priorities of the breeding programs in three regional crop improvement hubs in Hyderabad, Bulawayo and Bamako. The hubs will have improved facilities, improved seed processing and grading systems. We will have rapid generation advancement so that breeding cycles are much shorter. We are digitalizing all data collections. We want to measure the genetic gains in our crops and make sure there is varietal turnover in farmers' fields that shows significant impact from the upstream research we do through the breeding programs and seed system delivery into farmers' fields.

We have achieved much in 2019 – this Annual Report has the details – and I look to 2020 as a year of continued delivery of impacts and achievements for ICRISAT and its many stakeholders.

Dr Peter Carberry
Former Director General, ICRISAT

Message from the **Director General**

Sustainable, productive and impactful – that is what I would want ICRISAT's work to be over the next years and to be able to achieve the Sustainable Development Goals in the semi-arid tropics by 2030. It is going to be a tough challenge but I think we can contribute in a big way towards achieving them. Leadership, vision and commitment are vital. In order to succeed, we need a good strategy to allow ICRISAT to position itself in this changing world with One CGIAR and the COVID-19 taking precedence over other issues.

I have been looking through the Annual Report 2019 and I am sure you are all proud of the Research for Development impacts in there – reaching millions of farmers, millions of hectares, new varieties, numerous countries, thousands of tons of certified seed and production of millions of tons of grain. The impacts in genomics, watersheds, agronomy, digital agriculture, genebank, nutrition and food systems are impressive. Breeding is a huge part of our work and we need to build and improve the current rate of modernization. We need to bring in all those modern tools out there in all areas – mechanization, digitalization and data management.

ICRISAT is doing a wonderful job and we need to keep building on that. As we move into the future, our key drivers would be productivity, teamwork, partnerships, excellence, resources and opportunities. Our world is never going to be the same again with two imperatives that shape our future work environment. These are new situations; nonetheless they are great opportunities to bring about change. We need to be adaptable and we need to have resilience in this new normal that we are going to encounter as we move forwards.

Dr Jacqueline d'Arros Hughes
Director General, ICRISAT

Contents

A wild species of pearl millet shot at ICRISAT glasshouse in Hyderabad.

Photo: S Punna, ICRISAT

Research Highlights - Quick Stats

A world without hunger is what ICRISAT envisions. With an ever-increasing population, the year 2019 saw us pursue this vision with greater vigor. **Mainstreaming nutrition** and **modernizing the breeding program** were top priorities even as we roped in the best of genomic and digital technologies to increase efficiencies and deliver improved farmer-preferred varieties in half the time. Landscape restoration adopting a holistic approach that spans the **entire agriculture value chain** has shown great impact in improving food security, incomes and **climate resilience** of farmers. Our partnerships with governments, the public and private sectors, NGOs, NARS and CGIAR partners have helped reap the impacts showcased in this report.

Dr Kiran K Sharma
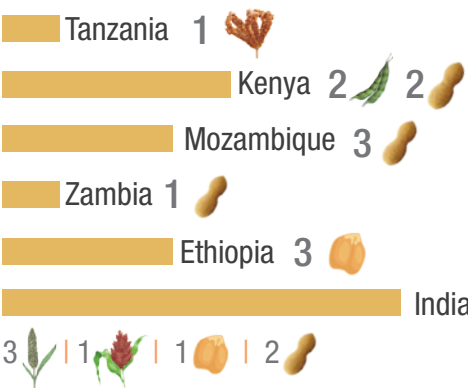*Deputy Director General-Research, ICRISAT*

▶ WORK ACROSS THE SUSTAINABLE DEVELOPMENT GOALS

In 2019, we worked with over **163 partners** from **27 countries** to contribute to **16 SDGs**

▶ CROP IMPROVEMENT

Variety releases

19 Varieties   **6** Countries   **6** Crops

Country	Value
Tanzania	1
Kenya	2 2
Mozambique	3
Zambia	1
Ethiopia	3
India	3 1 1 2

Varieties in National Performance Trials

336 germplasm/breeding lines/experimental hybrids

▶ GENEBANK

2,840 accessions prepared in 2019 were deposited at **Svalbard Global Seed Vault** in early 2020

15,000 seed samples distributed in **15 countries**

▶ SEED PRODUCTION

Seed shared with farmer groups, NARS# and NGOs

64 tons breeder seed   **8,729** tons certified seed

5,996 tons foundation seed   **1,397** tons QDS/truthfully labelled

▶ DIGITAL AGRICULTURE

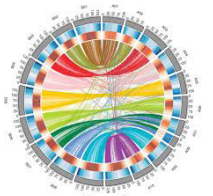**110,362,150** farmers reached through 22 digital initiatives

▶ AGRI-FOOD SYSTEMS

Soil management reach

Direct area **~6,099,448 ha** (9 countries in Asia and Africa)

Watershed coverage (India, Ethiopia, Mali)

Direct area **~117,955 ha**   Spillover **~193,524 ha**

▶ GENOME SEQUENCED

Decoded genome sequences for two subspecies of cultivated groundnut

National Agricultural Research Systems; * Figures sourced from MEASURE

Growing incomes, nutrition, resilience and gender equality

Livelihoods

Doubled yields, doubled incomes

- Pilot watershed projects in India and Ethiopia show how farmers' incomes can be doubled with landscape restoration and the use of improved varieties.
- High-yielding and machine-harvestable chickpea variety tested on Indian farms results in tripled yields and savings on labor costs.
- Improved groundnut varieties triple yields of seed producers in Africa.

Agronomy and market traits for released varieties

1.	High grain yield
2.	Early maturity
3.	Abiotic stress tolerance
4.	Biotic stress tolerance
5.	**Nutrition**
6.	Grain/pod size
7.	Ethanol, biomass, others
8.	Culinary
9.	Fodder yield
10.	Machine harvestability

(order based on weightage)

Nutrition

Biofortification and culinary traits

- High iron and zinc
- High iron and zinc
- Calcium, iron and zinc
- Protein
- Digestibility, protein
- High oleic, protein

Smart Food study shows significant increase in growth parameters (BMI and HAZ)* compared to control group in school children fed millet-based meals vs micronutrients fortified, rice-based meals.

* Body mass index (BMI); Height-for-age Z-scores (HAZ).

Environment & Climate

Digital technologies: Launched the world's first fully automated system for plot monitoring called agCelerant that provides climate solutions for Nigerian Agriculture.

The Meghdoot App, an ICT-enabled climate tool developed for the Indian government had >50,000 downloads.

Fewer hunger months: Reliance on food aid halves in a Ghanaian climate-smart village and Ethiopian watersheds.

Scaling up technologies: Watersheds in Africa and India have had requests for replication from governments.

Climate Research facility set up at ICRISAT headquarters.

Less land and water conflicts lead to improved prosperity in watershed projects in Ethiopia.

Gender

What women farmers want**

- Insights were generated on gendered seed knowledge, access and use in Uganda.
- GENDER Platform focuses on transforming food systems for gender equality in a climate crisis.
- Gender-responsive Plant Participatory Breeding Programs initiated in Africa.
- South-South collaborations in agribusiness: Participants from 22 African countries (50% women) trained to be entrepreneurs.
- Indigenous women farmers in India influence community diets and earn incomes.

**Contributions from the CRP Grain Legumes and Dryland Cereals led by ICRISAT

Legend		
Sorghum	Finger millet	Pearl millet
Chickpea	Pigeonpea	Groundnut

In West and Central Africa

Photo: A Diama, ICRISAT

CROP IMPROVEMENT FOCUS

SORGHUM »

Biofortified sorghum
Nigeria   Mali

PEARL MILLET »

Commercial hybrids
Niger | Nigeria | Burkina Faso
Ghana | Senegal | Mali

Dual purpose
(Grain and fodder)
Niger

AGRONOMY IMPACT

Contour bunds | Mali

Climate-smart village | Ghana

Good agricultural practices | Nigeria

FAW[1] biological control | Niger

ISSFM[2] and food security | Mali

DIGITAL INTERVENTIONS

Geospatial technologies | Nigeria

[map of Africa with Niger, Mali, Senegal, Burkina Faso, Ghana, Nigeria labeled]

[1] Fall armyworm
[2] Integrated Striga and Soil Fertility Management

Highlights

► CROP IMPROVEMENT FOCUS

Biofortified sorghum

Lines identified (Nigeria)

New germplasms screened
320

Two clusters identified with higher mean values of iron (Fe) and zinc (Zn)
Fe 11-80 ppm   Zn 8-42 ppm

Varieties identified (Mali)
6 High Fe | **5** High Zn | **1** High Fe and Zn

Commercial pearl millet hybrids (Niger, Nigeria, Mali, Burkina Faso, Ghana and Senegal)

Wider adaptability and yield stability (ICMH 177111)
Highly adapted to Burkina Faso (ICMH 147007)
• High-yielding and resistant to downy mildew
• Awaiting release in Burkina Faso for commercial use
• Training of seed companies and developing Hybrid Parents Research Consortium is in progress.

Best dual-purpose millet (Niger)

ICMV 167005 and ICMV 167006 were recommended for improving crop-livestock farm system in Niger.

► PROJECT IMPACT (ATASP-1[*])

Sorghum flour makes it to supermarkets (Nigeria)

Improving industry interface with flour millers resulted in bringing out packaged sorghum flour. It came with added shelf life due to techniques developed by the millers. Varieties Samsorg 17, Samsorg 45 and Samsorg 47 suited millers.

► DIGITAL INTERVENTIONS

► AGRONOMY IMPACT

Contour bunds and agroforestry (Mali)

Increased water conservation

37-19% reduced runoff | **>2 meters** rise in water table | **20%** soil moisture increase

Climate-smart village (Lawra-Jirapa in Ghana)

Impact on households
Food security status improved, with more than half of the households experiencing fewer than 4 hunger months a year.

Good Agricultural Practices (Nigeria)

Practices that led to increase in sorghum grain yields

Improved varieties **30-64%** | Seed dressing **27-38%** | Tillage practices **0-55%**

40% increase in average yield

1.5 t/ha experimental plot
1.1 t/ha farmers' practice

Fall armyworm – Biological control (Niger)

Technique for mass multiplication of the parasitoid *Telenomus remus* developed for use in biological control.

Increased food availability due to ISSFM (Mali)

ISSFM adopters **664 kg/ha** yield | Non-adopters **451 kg/ha** yield

Adoption and impact of integrated Striga and soil fertility management strategy in Mali (B Felix et.al) (Page 287)

① World's first fully automated system for plot monitoring

NADiRA – Nurturing Africa's Digital Revolution for Agriculture – interfaced a Geospatial Exploitation Platform (GEP) with the agCelerant digital value chain orchestrator to build the world's first fully automated system for plot level monitoring. It is prototyped on Google Cloud.

[*] Agricultural Transformation Agenda Support Program Phase-1

In Eastern and Southern Africa

Photo: ICRISAT-Ethiopia

CROP IMPROVEMENT FOCUS

PIGEONPEA
Kenya | Tanzania
Uganda | Malawi

- Drought tolerant
- Wilt resistant
- Ratoonable
- Pest tolerant
- Climate resilient
- High biomass
- Suitable as a vegetable

SORGHUM ≫ Kenya | Tanzania | Uganda

- Food
- Feed
- Malting
- High yield
- Cooking time

PEARL MILLET ≫
Kenya | Tanzania | Uganda

- High-iron
- High yield

GROUNDNUT ≫
Kenya | Zambia | Tanzania | Uganda | Malawi | Mozambique
High yield, agronomic and market-preferred traits, drought and disease resistant

CHICKPEA ≫ Ethiopia | Kenya | Malawi

- High yield
- Blight & wilt resistant
- Earliness
- Double podded
- Drought resistant
- Machine harvestable
- Consumer-preferred grain traits

FINGER MILLET ≫
Uganda | Tanzania | Kenya | Ethiopia

- Nutrient content
- High yield
- Lodging resistant
- Blast resistant

AGRONOMY IMPACT

Landscape restoration | Ethiopia
Crop response to fertilizer | Ethiopia
Legume-maize intercropping | Malawi

PARTNERSHIPS & APPROACHES

Hybrid Parents Research Consortium operationalized | Kenya
Nutrition-sensitive multi-sectoral approach | Malawi
Project engagement with policy makers | Kenya

Ethiopia
Uganda
Kenya
Tanzania
Malawi
Mozambique
Zimbabwe

Highlights

▶ CROP IMPROVEMENT FOCUS

Varieties released (Kenya, Mozambique and Zambia)

Groundnut with agronomic and market-preferred traits

6 varieties (large seeded, preferred for oil extraction, drought and disease resistant, high-yielding)

Multi-trait pigeonpea (Kenya)

2 varieties (drought tolerant, wilt resistant, suitable for dry grain and green vegetable peas, amenable to ratooning)

High-yielding finger millet (Tanzania)

1 variety (High-yielding with big heads and moderate resistance to lodging. Resistant to stem borer, blast and tolerant to drought)

Lines in National Performance Trials

25 varieties **Finger millet** (Ethiopia, Malawi and Tanzania)
15 varieties | **2** hybrids **Sorghum** (Kenya, Tanzania and Uganda)
7 varieties **Chickpea** (Kenya and Tanzania)
3 varieties **Pigeonpea** (Kenya)
8 varieties **Groundnut** (Tanzania, Uganda and Malawi)

Selections from participatory variety trials

4 best varieties | **Pearl millet** (Kenya and Tanzania)
7 best varieties | **Finger millet** (Tanzania)
2 best varieties | **4** hybrids | **Sorghum** (Tanzania)

▶ PARTNERSHIPS & APPROACHES

Public-private partnerships (Kenya)

Sorghum and Pearl Millet Hybrid Parents Research Consortium operationalized.

Working with governments (Malawi)

Malawi Seed Industry Development Project II impacts:

- ICRISAT's nutrition-sensitive multi-sectoral intervention was selected by Dedza district nutrition coordinating committee as a best practice.
- Submission of rigorously tested groundnut-based recipes to the Malawi national recipe book.
- A food safety curriculum on aflatoxin contamination was developed to be incorporated in the national nutrition training manuals.

*Accelerated Value Chain Development Project of Feed the Future;
**Seed of select drought tolerant cereals and legumes.

Impact of AVCD* project - Phase I (Kenya)

Community seed system established

34 tons of seed** shared with **10,664** farmers
89 trained seed growers currently run the seed system.

Contribution to the County Nutrition Action Plans

36 community health volunteers trained
882 caregivers trained on consumption of diverse diets

App for market information
Farmers learn to use a digital application 'Sourcetrace' that supports farmer registration, E-extension, aggregation and marketing.

▶ AGRONOMY IMPACT

Doubled-up legumes (Malawi)

Simulated maize-legume integration showed:
50% saving in fertilizer costs for maize production

Developed a fertilizer use guide (Ethiopia)

Able to predict crop response to fertilizer application using remote sensing and ground truthing with a precision level between **65-75%**.

Terraced-treated farms (Yewol watershed, Ethiopia)

25-54% higher crop yield compared to non-terraced farms

Impact of water spreading weirs (Afar, Ethiopia)

Harnessed flood re-greens **46** ha degraded rangelands
10-12 t/ha biomass produced on average in a year
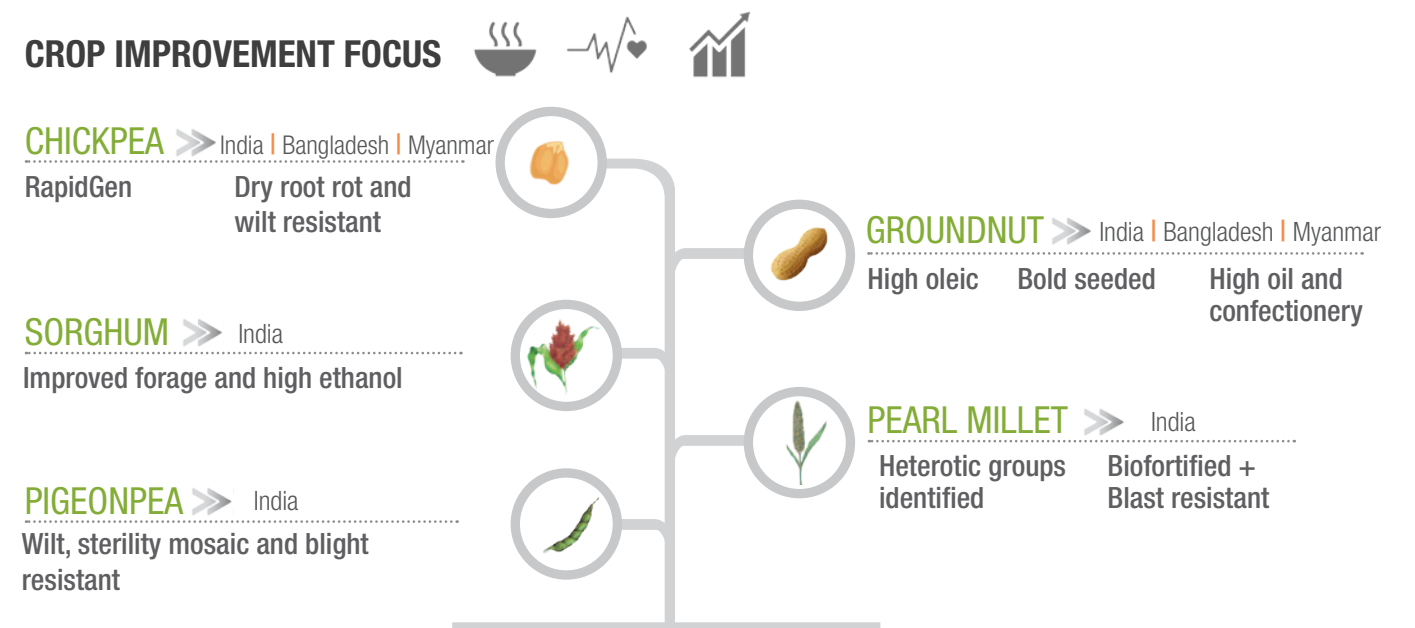**3.5** M ha can benefit from scale-up of this technology

Innovation transforms livelihoods of pastoralists in Ethiopia

In Asia

Photo: ICRISAT

CROP IMPROVEMENT FOCUS

CHICKPEA ›› India | Bangladesh | Myanmar

RapidGen   Dry root rot and wilt resistant

SORGHUM ›› India

Improved forage and high ethanol

GROUNDNUT ›› India | Bangladesh | Myanmar

High oleic   Bold seeded   High oil and confectionery

PEARL MILLET ›› India

Heterotic groups identified   Biofortified + Blast resistant

PIGEONPEA ›› India

Wilt, sterility mosaic and blight resistant

AGRONOMY IMPACT

Soil health interventions | India

Rainwater harvesting | India

Corporate Social Responsibility initiative | India

CLIMATE RESEARCH

New facility set up for climate change research on plant protection | India

CAPACITY BUILDING

Groundnut production and aflatoxin testing
Vietnam | Myanmar | Bangladesh | Laos PDR

(Map showing: Bangladesh, Laos PDR, India, Myanmar, Vietnam)

Highlights

▶ **CROP IMPROVEMENT FOCUS**

CHICKPEA

RapidGen advancement

Crop cycle reduced by half under semi-controlled greenhouse conditions

Generations per annum:	1 Normal practice	3 Earlier protocol*	6-7 RGA protocol

*Developed by ICRISAT

Stable resistance to wilt (India)

6 genotypes identified across multilocations

Pod borer and *Helicoverpa* tolerance

ICC 506EB tolerant to pod borer and *Helicoverpa armigera* was shared with NARS partners for multi-location testing.

PEARL MILLET

Heterotic groups identified (India)

This information on seed and restorer parents can be used to generate new higher-yielding series of hybrids.

High Fe and Blast resistant (India)

7 lines identified

SORGHUM

Improved forage quality (India)

- Hybrid **CSH 24 MF** [52% in vitro organic matter digestibility (IVOMD)] was recognized for revolutionizing forage production in India.
- 150 high biomass sorghum lines with more than 55% IVOMD identified for commercializing.

For every 1% increase in IVOMD, there is a >5% increase in animal weight gain and milk yield.

Higher ethanol recovery in sorghum (India)

50 sweet sorghum lines with more than 22% brix content identified for commercial ethanol production.

Ethanol per ton of biomass

40-45 liters/ton
Currently available cultivars

56 liters/ton
Identified 50 lines

GROUNDNUT

First 'high oleic' variety released (India)

Salient features: Longer shelf life and health benefits

A fast-track breeding strategy employing genotyping, phenotyping and RGA resulted in the development and commercialization of high oleic lines in just eight years.

Bold-seeded groundnut with market traits (Bangladesh)

Lines from multilocation testing advanced to national testing

2 early-maturing lines (ICGV 00338, and ICGV 02038)

1 drought-tolerant line (ICGV 07219) with bold seed size of 40-60 counts/ounce

Rapid detection tools for allergens (India)

ELISA* protocol was standardized for precise detection of groundnut allergens.

*Enzyme linked immunosorbent assay

DID YOU KNOW ?

316 improved varieties/hybrids were developed in partnership with the Indian NARS as of 2019.

41,796 germplasm accessions were repatriated.

Many of these varieties are first of their type and have covered a lot of area under crops in the country.

Source: ICAR Annual Report (2018-19). Figures as of December 2019

Photo: ICRISAT

High-yielding groundnut variety ICGV 91114 has financially benefited farmers in Odisha and Andhra Pradesh states.

PIGEONPEA

Wilt and Sterility Mosaic Disease resistant and Blight tolerant (India)

- **10 lines** identified. These were shared with NARS.
- ICPL 332 WR (TDRG 4) resistant to wilt and tolerant to pod borer and *Helicoverpa* released in Telangana.

▶ CLIMATE RESEARCH

Developed state-of-the-art climate change facilities such as CO_2 and temperature gradient tunnels, free air CO_2 enrichment facilities and open top chambers to study population dynamics, lifecycle of pathogens, pest and disease expression and host response under simulated climatic conditions.

- In pigeonpea, significant changes in crop phenology were observed with increased temperature and CO_2 as compared to ambient.

▶ CAPACITY BUILDING

Training NARS staff and private companies

(Vietnam, Myanmar, Bangladesh and Laos PDR)

67 trainees from the government agriculture department, NGOs, private seed companies and research centers

*National Agricultural Research System (NARS)

Photo: ICRISAT

▶ AGRONOMY IMPACT

Watershed impact in Andhra Pradesh and Karnataka states (India)

The project bagged the National CSR Award for betterment of the lives of nearly 20,000 people through integrated watershed management in Kurnool, Andhra Pradesh and Vijayapura, Karnataka.

Rainwater conservation and improved water use efficiency (WUE) through construction of farm-based ponds and other community structures resulted in water storage of 200,000 m^3.

30-60% farm losses reduced due to access to water

10-50% increase in crop yields with improved nutrient and crop management practices

500 women farmers involved through livestock-based activities and kitchen gardens.

Soil test-based nutrient management in Odisha (India)

Increase in crop productivity

10-40% finger millet, pigeonpea, groundnut, rice and maize

Interventions

40,265 soil samples analyzed

30 sites of learning established

- An online portal on soil health maps was set up (URL: http://111.93.2.168/odsoil/).

Watershed impact in Bundelkhand (India)

- Identified high water harvesting potential **~ 20%** of the planned rainwater harvesting structures were executed

Impact: ~ 0.5 million m^3 of water was made available in the region.

- Increased cropping intensity

25-80% average increase in yield

- Impacts led to reversing migration of smallholders who had left farming a decade ago.

Modernizing breeding

Crop scientists at ICRISAT are striving to achieve disease resistance, stress tolerance and nutritional improvement in our mandate crops. Modernization of the breeding programs aims to increase rate of genetic gain by focusing on improving components of the Breeders' Equation. This includes rapid generation advancement methods, utilization of data-driven decision-making digital platforms, molecular tools and advanced phenotyping technologies. These are the key areas of focus for enhancing productivity and boosting varietal development in a demand-driven approach.

ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS
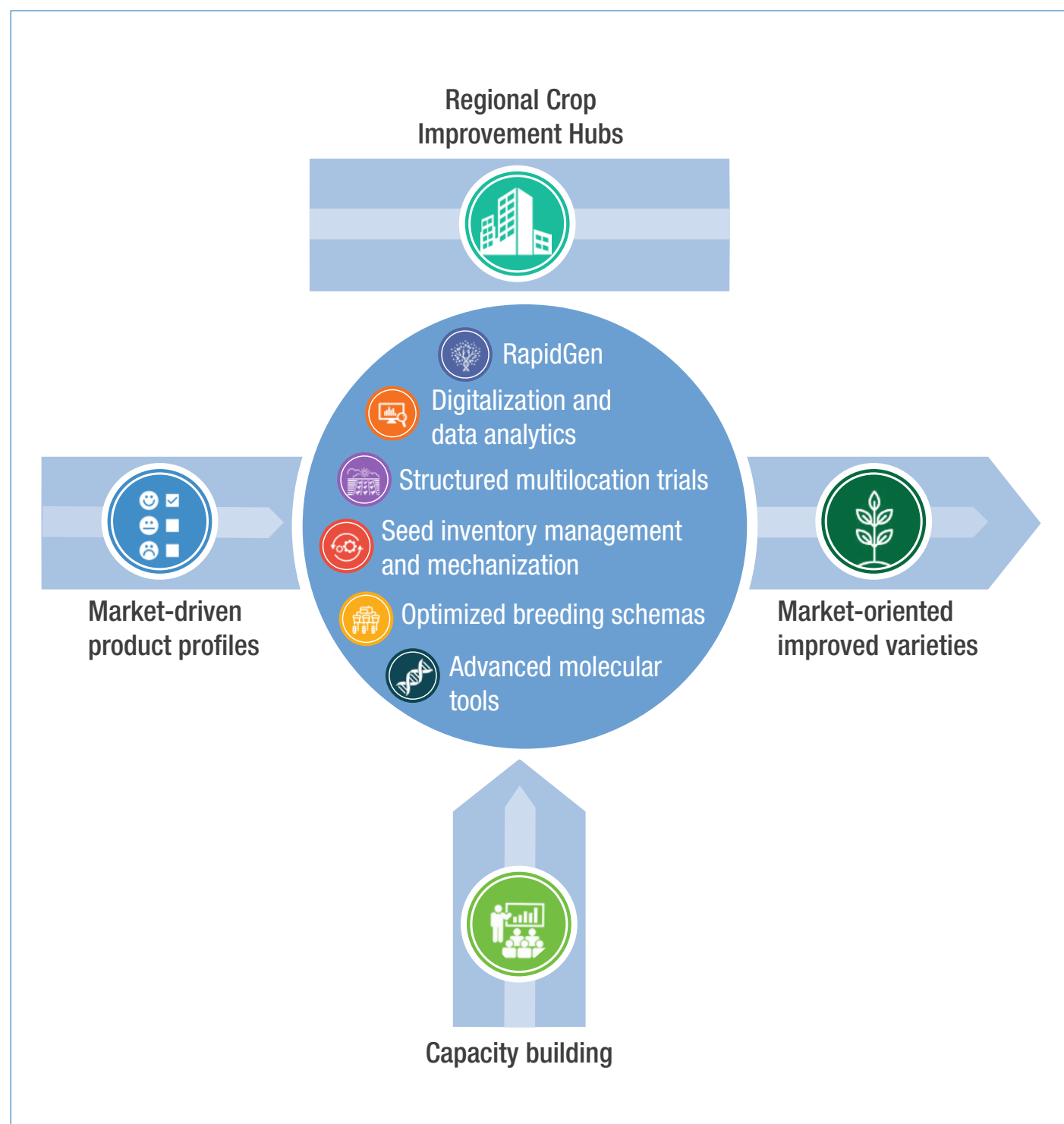
LIFT-OUT SECTION

Photo: G Rajesh, ICRISAT

Modernizing breeding: THE ICRISAT PLAN ▶

An efficient and advanced crop breeding program contributes to higher genetic gains. Our breeding programs are designed to be focused, agile, cost-effective, and efficient. Here's how we are staying ahead of the curve.

Regional Crop Improvement Hubs

- RapidGen
- Digitalization and data analytics
- Structured multilocation trials
- Seed inventory management and mechanization
- Optimized breeding schemas
- Advanced molecular tools

Market-driven product profiles

Market-oriented improved varieties

Capacity building

Why?

Modern breeding programs contribute towards food security by increasing rate of genetic gain in farmers' fields and overall farm productivity.

Why now?

Food security: Maintaining a steady growth of sustainable food production is critical to achieving the UN Sustainable Development Goal of Zero Hunger (UN SDG 2) by 2030.

Climate change: Breeding climate-resilient crops that can give high yields in a changing climate is the need of the hour.

Nutrition: With over 640 million inhabitants in the semi-arid tropics, we need crops that are nutritious and environmentally resilient.

Why us?

We work in the semi-arid tropics, home to over 2.5 billion people, most of whom are smallholder farmers. Our crops are grown in these regions and conditions, making them the staple food for many people.

A short (hi)story

In 1990, CCS Haryana Agricultural University (CCSHAU) released an early-maturing pearl millet hybrid HHB 67, which was rapidly adopted by farmers in north-western India and by 2002, was cultivated on approximately 774,000 ha in southern Haryana and central Rajasthan.

When Downy Mildew (DM) disease attacked it and started affecting crop yields, CCSHAU and ICRISAT together developed HHB 67 Improved, using marker-assisted back-crossing (MABC), among other techniques. This high-yielding, DM-resistant hybrid was released in 2005.

Most pests/diseases attack suddenly, with very little warning and little reaction time, e.g. Blast infestation in pearl millet in Asia and Africa in the past decade. Developing blast-resistant pearl millet is one of the top priorities due to demand from NARS breeders and seed companies.

Modernization of our breeding programs will enable responding to such threats on time, with quality and speed by utilizing and integrating latest tools and technologies.

1 | Regional Crop Improvement Hubs (RCIH)

Regional Crop Improvement Hubs set up in India, Zimbabwe in Eastern and Southern Africa (ESA) and Mali in West and Central Africa (WCA) to stimulate and support breeding programs in the region. Each hub, led by a Regional Breeding Lead, to work across the disciplines of breeding, physiology, integrated crop management, and genomics and trait discovery for delivering better product faster.

2019 updates

- Crop Improvement Operations Team set up
- Regional Breeding Leads for Asia and ESA recruited
- Crop Improvement Operations Team Lead for Asia appointed
- Product Placement Lead for Asia and ESA appointed.

https://www.icrisat.org/individual-crop-improvement-operations-merge-into-a-single-entity-for-greater-efficiency/

Photo: S Punna, ICRISAT

2 Market-driven product profiles

Photo: M Magassa, ICRISAT

https://www.icrisat.org/breeding-future-ready-crops/

Developing concept notes and product profiles with a focus on markets.

2019 updates

>**570** stakeholders consulted

- Three product concepts defined to complement NARS[*] activities in West Africa
- Two product profiles for groundnut identified
- Product concepts developed for pigeonpea (3) and chickpea (4) in ESA
- Consultation meetings held with partners.

_____
*National Agricultural Research Systems (NARS)

3 Seed inventory management and mechanization

Accurate, faster operations with precise cataloging and use of mechanized tools.

2019 updates

- Further progress made on digitalization of seed inventory at ICRISAT Hyderabad
- Seed processing mechanization infrastructure purchased - expected to save US$ 300,000 within two years and hours of labor
- X-Ray Fluorescence facility set up at WCA for grain iron (Fe) and zinc (Zn) analyses in pearl millet, sorghum and finger millet
- Near Infra-Red Spectroscopy (NIRS) machines installed to quantify protein, oil, ash and oleic acid in groundnut
- HarvestMaster for grain weight and moisture content assessment
- Fully barcoded field plots and seed storage labels
- In ESA, genebank renovated and modernized; workspace optimized; standard operating procedures for infrastructure and safety guidelines developed.

Photo: ESA, ICRISAT

4 Optimized breeding schemas

Photo: S Punna, ICRISAT

Enhanced breeding schemas such as Single Seed Descent and General Combining Ability to increase selection accuracy and intensity while retaining sufficient levels of genetic diversity.

2019 updates

- Workshop held with Excellence in Breeding platform (EiB) for understanding simulation platform to evaluate various breeding schemas
- Increased breeding efficiency by adoption of Breeding Costing Tool in ESA.

5 Advanced molecular tools

Advanced technology for accurate prediction of genetic value for long-term gain.

2019 updates

- Several markers for traits in pigeonpea converted to High Throughput Genotyping (HTPG), expected to facilitate early screening, marker-assisted back-crossing (MABC)
- Improved efficiency of early generation selection in chickpea for Ascochyta blight
- Identified Single Nucleotide Polymorphism (SNP) markers in pearl millet for iron and zinc content
- Trait-based genotyping for shoot fly resistance, drought tolerance, fertility restoration in sorghum and blast resistance in finger millet.

Photo: ICRISAT

https://www.icrisat.org/first-ever-high-yielding-chickpea-variety-developed-using-marker-assisted-backcrossing-mabc-released-in-ethiopia/

6 Digitalization and data analytics

Data science, machine learning and artificial intelligence contribute to significant reduction in time taken to deliver varieties with desirable traits.

Photo: ICRISAT

2019 updates

- Automated experimental design generation (crosses, trials, germplasm inventory) using Breeding Management System (BMS)
- Crosses made within BMS
- Digital data collection using tablets with appropriate software (e.g. FieldBook)
- Digitalized germplasm lists
- Barcodes for research plots to track seed and genotyping samples
- Genomic Open-Source Breeding Informatics Initiative (GOBii) database: data loading and development of user-friendly breeding tools
- Breeding view and GenStat software being utilized that enables analysis of unbalanced data and fitting mixed models.
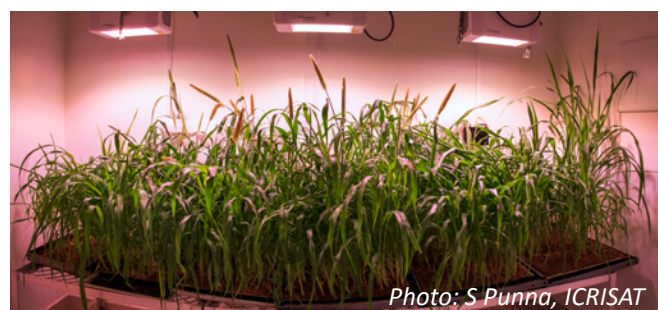
7 RapidGen

Generation time is a game changer for achieving maximum genetic gains in crop plants. Generally, it takes seven to eight years to develop homozygous (identical) lines after hybridization with one crop generation produced per year. For instance, the Rapid Generation Advancement protocol (RapidGen) allows the production of six to seven generations of chickpea in a year under controlled glasshouse conditions.

2019 updates

- RapidGen streamlined in partnership with industry (Corteva Agriscience) and the University of Queensland, Australia
- Infrastructure set up for RapidGen Protocol Optimization and production for mainstreaming RapidGen in the Asia hub
- Effects of varying photoperiod and temperature for chickpea, pearl millet, sorghum and groundnut optimized
- Methods to enable high density sowing to produce healthy, viable seeds optimized for rapid generation cycling. These can be used at multiple stages of crop breeding programs

- Pearl millet and sorghum breeding programs to transition to RapidGen beginning 2020.

Photo: S Punna, ICRISAT

https://www.icrisat.org/new-chickpea-breeding-protocol-promises-to-bring-down-varietal-development-time-from-12-years-to-6-years/

8 Structured multilocation trials

Planned multilocation trials for data to accurately estimate yield, determine pattern of response for genotype/agronomic treatments and provide reliable guidance for selecting the best genotypes or agronomic treatments for planting in future years and at new sites.

Photo: C Ojiewo, ICRISAT

2019 updates

- Increase in pearl millet varieties/hybrids from 100 to 150 in multilocation testing trials
- Advanced pearl millet lines evaluated at 15 locations in WCA representing target environments for three product concepts of Sahelian and Sudanian zones. Totally, 90 sites per season will be used
- Strategic multilocation trials for chickpea and groundnut carried out.

9 Capacity building

From genomics to operations to data analysis, capacity building among scientists, farmers, extension workers and other stakeholders is an ongoing process.

2019 updates

Breeding
- Leadership Training workshop on change management, team building and behavioral change in Arusha, Tanzania (30 participants)
- Excellence in Breeding Platform Annual Meeting in Amsterdam focused on modernization of CGIAR centers' breeding programs
- Training on using digital seed catalog, seed roadmap, MEASURE[1] platform for MEL platform (91 participants)
- Digitalization of breeding programs and data management (63 participants).

Genomics
- Training on next-generation genomics for crop improvement
- International workshop on genomic selection for crop improvement for participants from India, Australia and UK
- Organized 10K Chickpea Sequencing Initiative involving University College of London, BGI-Shenzhen and ICRISAT.

Data management
- Extended advanced data science support to 10 crops of the Indian Council of Agricultural Research (ICAR)
- Introduced digital interventions in NARS partners in ESA and WCA through Tropical Legumes III, HOPE[2] 2 and AVISA[3] projects.

https://www.icrisat.org/hands-on-training-for-modernizing-crop-breeding-programs/

[1] Monitoring and Evaluation of Agri-Science Uptake in Research & Extension; [2] Harnessing Opportunities for Productivity Enhancement for Sorghum and Millets (HOPE); [3] Accelerated Varietal Improvement and Seed Delivery of Legumes and Cereals in Africa (AVISA)

Breeders' equation

What is genetic gain? The amount of increase in performance achieved in a generation through targeted selection determined in a crop breeding program by the following breeders' equation:

$$\triangle G = \frac{i \times r \times \sigma_A}{L}$$

Genetic gain over time

Selection intensity — i

Selection accuracy — r

Genetic standard deviation — σ_A

Generation interval — L

Genetic gain can be increased by:
Enhancing selection intensity
Increasing accuracy
Increasing variance and/or
Shortening the breeding cycle interval.

The initiative to streamline our crop improvement programs is a concerted effort to accelerate genetic gains in our mandate crops, resulting in faster delivery of varieties with higher yields, better nutritive value, stronger resistance to biotic/abiotic stresses and other desirable traits. These will help smallholder farmers in the dryland regions achieve financial and nutritional security, while causing minimal impact on the environment.

Acknowledgements

Breeding Program Assessment Tool — *maximizing genetic gain*

CGIAR Excellence in Breeding Platform

AVISA Healthier and Prosperous Africa
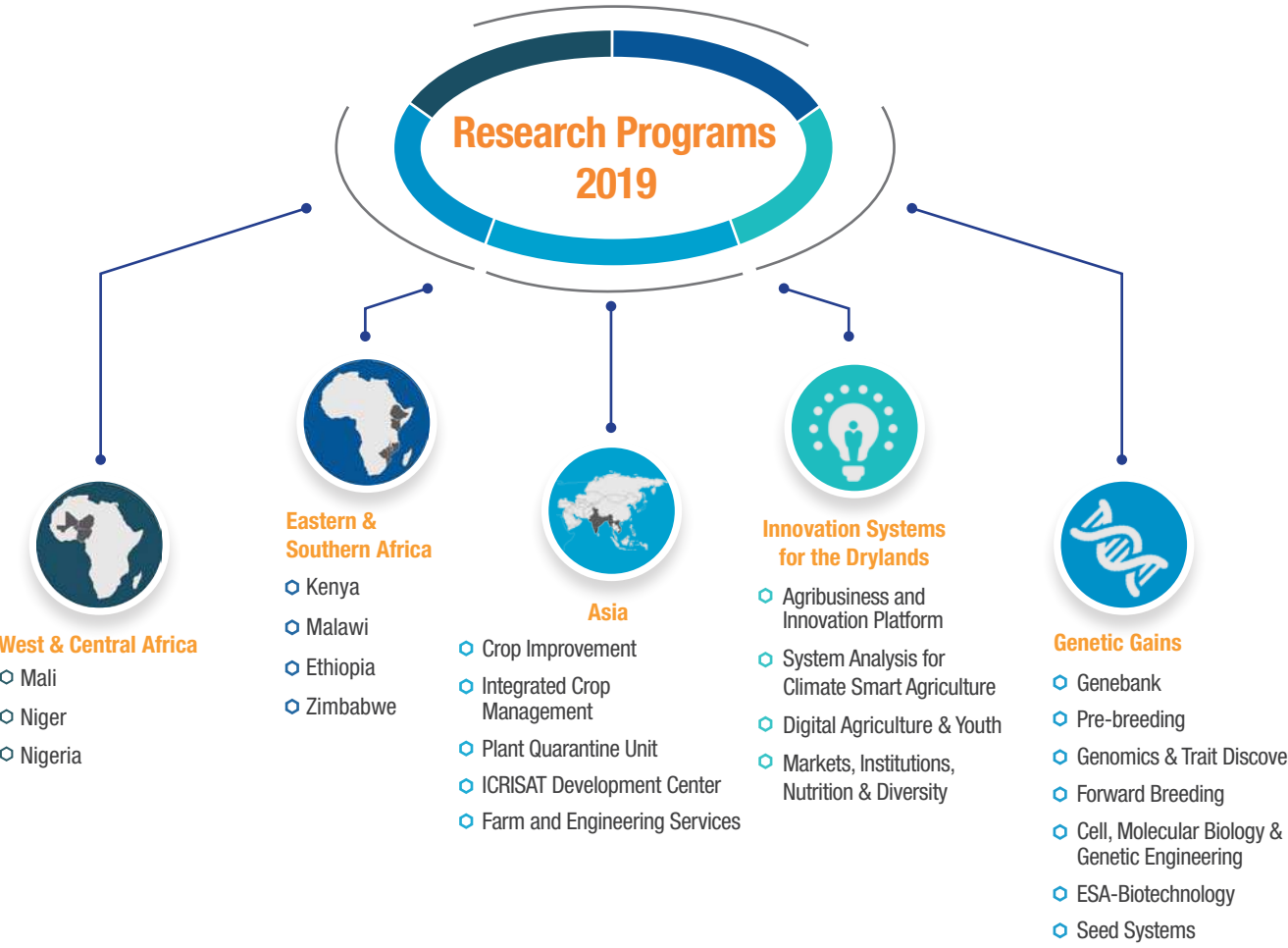
CGIAR Research Program on Grain Legumes and Dryland Cereals

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

ICRISAT-India (Headquarters)
Patancheru, Telangana, India
icrisat@cgiar.org

Vision
A prosperous, food-secure and resilient dryland tropics

Mission
To reduce poverty, hunger, malnutrition and environmental degradation in the dryland tropics

Approach
Inclusive Market-Oriented Development (IMOD)

Research Programs 2019

West & Central Africa
- Mali
- Niger
- Nigeria

Eastern & Southern Africa
- Kenya
- Malawi
- Ethiopia
- Zimbabwe

Asia
- Crop Improvement
- Integrated Crop Management
- Plant Quarantine Unit
- ICRISAT Development Center
- Farm and Engineering Services

Innovation Systems for the Drylands
- Agribusiness and Innovation Platform
- System Analysis for Climate Smart Agriculture
- Digital Agriculture & Youth
- Markets, Institutions, Nutrition & Diversity

Genetic Gains
- Genebank
- Pre-breeding
- Genomics & Trait Discovery
- Forward Breeding
- Cell, Molecular Biology & Genetic Engineering
- ESA-Biotechnology
- Seed Systems

ICRISAT leads ▶ CGIAR RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

ICRISAT is a partner in ▶
CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security / CCAFS
CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems
CGIAR RESEARCH PROGRAM ON Agriculture for Nutrition and Health
CGIAR RESEARCH PROGRAM ON Livestock and Fish
CGIAR RESEARCH PROGRAM ON Policies, Institutions, and Markets
CGIAR Genebank Platform
CGIAR Platform for Big Data in Agriculture

We **believe** all **people** have a **right** to **nutritious food** and a **better livelihood.**
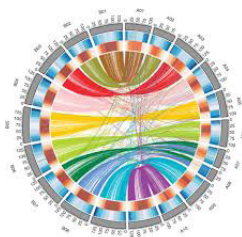
Genetic Gains

Trainees working in DNA Extraction lab.

Photo: ICRISAT

Cultivated groundnut genome sequence cracked

Decoded genome sequences for two subspecies of cultivated groundnut leading to improved understanding of genome organization, gene function and groundnut improvement.

The new tetraploid groundnut genome sequences for *A. hypogaea sps. hypogaea* and *A. hypogaea sps. fastigiata* are available to researchers and plant breeders across the globe to aid in the breeding of more productive and resilient groundnut varieties.

Chickpea accessions resequenced

429 accessions from **45 countries** resequenced to gain insight into genome diversity, domestication and agronomic traits.

39 scientists from 21 research institutes around the world were involved in the project.

Nutrition focus

▶ **India's first High Oleic groundnut**

▶ **Aflatoxin-resistant groundnut:** With technical proof of concept demonstrated, the stage is set to progress to early development, and regulatory strategies towards product development. Collaborations with West African NARS (Senegal, Nigeria and Mali) are in place to enable the release and utilization of these technologies.

▶ **Diabetic friendly, low glycemic index hybrid pearl millet**

▶ **Sequence-based markers for seed protein content in Pigeonpea:** Four sequence-based markers derived from mutations in four genes were identified for enhancing/regulating **seed protein content** in pigeonpea crop improvement programs.

Role of staygreen QTLs in sugar metabolism

Dissected role of staygreen quantitative trait loci (QTLs) in sugar metabolism and transport in post-flowering drought conditions and identification of candidate genes. The results suggest that abscisic acid signaling plays an important role in post-flowering drought-induced remobilization of sugars to the reproductive sinks.

Genomics-assisted breeding for commercial cultivation

Molecular breeding (India)

First molecular breeding products released among oilseed and pulse crops in India

2 groundnut varieties with high oleic acid content – Girnar 4 (ICGV 15083) and Girnar 5 (ICGV 15090)

2 chickpea varieties for drought tolerance and Wilt resistance (Pusa Chickpea 10216 and Super Annigeri1)

Marker-assisted backcrossing

In Ethiopia, Geletu, a high-yielding and drought-tolerant chickpea variety using MABC was released.

3,822 kg/ha was the highest grain yield recorded

15% yield advantage over control variety Teketay

Wild *Cajanus* species for pigeonpea improvement

Pre-breeding lines in initial varietal trials (India) 2019-20 crop season

6 high-yielding pre-breeding lines selected for trials

1,400-3,000 kg/ha is the average yield potential

This development is significant on two counts. One is of pre-breeding lines, especially in mid-early maturity duration group, directly reaching the varietal pipeline. The second is the utilization of wild *Cajanus* species for broadening the 'stagnant' genetic base of pigeonpea cultivars in India.

Pre-breeding lines shared with NARS (India & Myanmar) for evaluation across locations for yield and related traits.

10 high yielding	**23** disease resistant	**20** salinity tolerant

Acquisition, characterization and distribution of germplasm (Genebank activities)

15,000 seed samples distributed in **15 countries**

1,325 unique germplasm accessions assembled from regional genebanks

>2,000 new accessions characterized

>10,000 accessions regenerated

>19,000 accessions tested for seed viability

>6,600 accessions tested for seed health

Promising germplasm sources identified
- Multi-trait specific accessions in sorghum
- Yield and nutrient specific accessions in kodo millet

Developed genomic resources for

Proso millet, kodo millet and little millet

Assessed diversity

Sorghum, pearl millet and pigeonpea diversity assessed within and among accessions through phenotyping and genotyping using DArTSeq

Standard Operating Procedures

Two documents on germplasm acquisition and safety duplication were published.

DID YOU KNOW ?

≈**90**% of the ICRISAT collection is duplicated at **Svalbard Global Seed Vault** for safety duplication   Read more

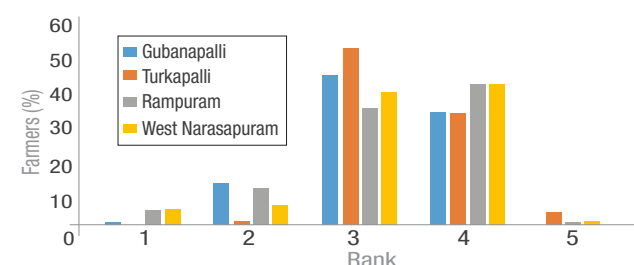Photo: ICRISAT

Innovation Systems for the Drylands

Photo: H Sabine, ICRISAT

ICT-enabled climate services impact (India)

>5,000 farmers in at least 10 districts made better decisions on planning and managing their farms through direct ICT-enabled **agro-advisories** since 2016.

Ranking of usefulness of ISAT advisories by participating farmers on a scale of 1-5.

Drone-based technologies

Acquiring and testing novel sensor-based technologies for accelerating development of climate resilient and nutritionally dense crop products.

Crop livestock integration and marketing (Malawi)

A project based on systems and value chain diagnostics initiated investments in a series of leverage points that support high potential livestock value chains, for developing scalable interventions.

3 district level Innovation Platforms feed into national level policy dialogue

≈ **900** farmers were trained and mentored on diversified crop and fodder production

South-south collaboration
(India Africa Forum Summit)

Trainings were conducted on setting up **small-scale food processing enterprises, food testing laboratories** and **scaling-up business** in the fruits and vegetables processing industry.

100 participants (50% women) attended

22 African countries participated

Improved on-farm water use efficiency (Zimbabwe)

Water management tools + Innovation Platforms impact

70% farmers reduced irrigation frequency

86% reported increases in yields of > 25%

43% reported increases in income

Policy makers agree to scale up technology

The National Zimbabwe Government Director of Irrigation agrees to scale up this strategy. ACIAR agreed to fund a second project.

30 irrigation schemes will use the technologies

~3,400 farmers on 1,380 ha to benefit by 2021

App for climate advisories (India)

The Meghdoot App, an ICT-enabled climate tool in collaboration with India Meteorological Department, Indian Institute of Tropical Meteorology and Indian Council of Agricultural Research is targeted to reach entire India.

Estimated impact

650 districts to be reached

Groundnut Primary Processing Centres impact (India)

3 centers were established in three villages

They are run by farmer members of a Food Producer Company (FPC) on a service-based model.

Postrainy season 2019 results

33 tons groundnut was processed

US$ 645 extra income earned by FPC

The project was supported by the Walmart Foundation. The FPC has around 6,000 farmer members.

New methods of crop monitoring using machine learning algorithms (Asia and Malawi)

Landsat data on Google Earth Engine: Used to derive agriculture cropland extent and area in Asia.

Moderate Resolution Imaging Spectroradiometer: Monitored changes in the cultivation of pigeonpea and groundnut in Malawi using **time series satellite imagery** for sustainable food systems.

Indigenous women farmers train to be 'nutrition entrepreneurs' (India)

In partnership with the Government of Telangana, **food processing units** were set up to procure local produce and make products for government's food and nutrition schemes in schools and welfare centers in the **tribal regions of Telangana**.

80 farmers formed into 8 Joint Liability Groups Each group will operate a unit and share profits

Estimated impact

100 farmers to benefit

20% increase in incomes

1.5 tons of food to be processed per day

Photo: AIP, ICRISAT

Read article

CRP-GLDC highlights

Contribution to SDGs

Adoption and ex-post impacts of improved cowpea in Nigeria

Over **20** improved varieties released

Adoption led to a **17 percentage point increase** in household income and a **5 percentage point reduction** in the incidence of poverty

929,450
people lifted out of poverty (Manda et al. 2019b)

Photo: IITA

Climbing bean technologies in Rwanda

0.8 million farming households increase productivity and food security

Raised per capita consumption expenditure by 0.9% and bean consumption by 2.8%.

Additional **117,480** tons of bean consumed by **4.4 million** people annually

4,714 households lifted out of poverty annually

Photo: CIAT

RESEARCH PROGRAM ON
Grain Legumes and Dryland Cereals
CGIAR

Early-maturing chickpea cultivars in Myanmar

Study on release of **10** cultivars (1976 to 2018)

Cropped area under improved chickpea increased from

67% 2001-02 | **97.7%** 2017-18

51% productivity gains; unit cost reduction at US$ 129/ton

US$ 152.8 m
Estimated benefits

Progress by Flagship Program (FP)

FP1: Priority Setting and Impact Acceleration

- Ex-ante nutritional impact assessment identified early-maturing sorghum with tolerance to drought and resistance to insect pests, and drought-tolerant cowpea varieties (WCA); intercropping-compatible pigeonpea varieties, early-maturing sorghum varieties and hybrids with tolerance to drought (ESA); and Fusarium wilt-, root rots-, and Botrytis grey mold (BMG)-resistant chickpea varieties in (SA).
- Identified user preferred traits for rainy season (white, large, globular and lustrous grains) and postrainy season sorghum (high starch, medium protein content and higher protein digestibility) to update product profiles in India.
- Research on gender and youth, youth realities, aspirations, transitions and opportunity structures in Uganda, Ethiopia and Tanzania, and youth engagement in seed systems in Mali and northern Nigeria. Read more

FP3: Integrated Farm and Household Management

- **Strategies for tackling new pests:** Assessed spatial and temporal distribution of emerging diseases of chickpea and pigeonpea (India)
- **Intercropping studies:** Evaluated agroecologies for soybean, cowpea, groundnut, pigeonpea and sorghum (Mozambique, Malawi, Burkina Faso and India)
- **Established demonstration plots:** 236 soybean (36% women) and 185 cowpea (39% women)
- **Doubled-up legume systems:** > 110,000 people benefit (Malawi)
- **Decision support tools developed** to assess impacts of legume-based technological interventions (Burkina Faso and Ethiopia). Read more

FP4: Variety and Hybrid Development

- 26 GLDC cultivars commercialized.
- Developed high oleic groundnut, cream seed-coated pigeonpea and large-seeded chickpea to meet industry needs, and machine harvestable chickpea and lentil for youth employment.

- Enhanced grain nutritional traits of lentil and groundnut and biofortified pearl millet cultivars.
- Fusarium wilt-resistant chickpea (India and Ethiopia), downy mildew-resistant pearl millet (India) and foliar fungal disease-resistant and aphid-tolerant groundnut (Tanzania and Mozambique) reduced input costs while providing environmental sustainability.
- Speed breeding deployed to reduce breeding cycle time from 0.5 years to 0.16 in chickpea and lentil, and from 0.5 years to 0.33 in groundnut.
- High-throughput SNP platform used for early generation selection in cowpea, groundnut, soybean, chickpea, pigeonpea, sorghum and pearl millet. Read more

FP5: Pre-breeding and Trait Discovery

- Identified 44 drought-tolerant wild cowpea lines that were crossed with elite varieties and incorporated into pre-breeding.
- Generated over 700K data points in all GLDC crops to develop markers.
- Advances made in the development of genomic selection in chickpea, groundnut, pearl millet and sorghum; identifying quantitative trait loci/ marker trait associations (QTLs/MTAs) for priority traits, transcriptomics data and epigenetic data on biotic and abiotic stresses in chickpea, and introgression and pyramiding of identified QTLs in breeding elite lines.
- Two high oleic groundnut lines (India) and three chickpea lines (India-2, Ethiopia -1) released.
- Identified candidate genes and markers for early and late flowering and adaptation to high temperature and dry environment in pearl millet using genome-wide association study.
- Established protocols for genome editing, second-generation transformation (pearl millet), systematic mutant population, genomic selection models, phenotypic screening, rapid generation turnover platform (pearl millet and sorghum), early stage leaf blast screening (finger millet) and high-quality draft genome assemblies (chickpea and pigeonpea). Read more

FP6: Common Bean for Markets and Nutrition

- Released 2 drought-tolerant, high-yielding, early-maturing varieties with high Fe and Zn, good marketability, palatability and tolerance to major diseases (Uganda).
- Improved varieties released (Zimbabwe and South Africa).
- Improved beans promoted and seed access through small packs (Tanzania, Uganda, Burundi, Kenya, Rwanda and Zimbabwe).
- Threshing and solar bubble dryer technologies introduced.
- Market survey conducted to identify and characterize yellow and other bean corridors. Read more

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Cross-cutting areas

Gender

- Gender-responsive variety development in sorghum and millet in WCA: Identified the most important traits for each value chain.
- Gained insights on opportunities available to women farmers in soybean seed systems in Mozambique.
- Generated primary data and insights on lentil farming, innovations and women empowerment in rural landscapes.
- Innovation on threshers, processing of beans to provide business opportunities for women.

Youth

- Teamed up with universities in Tanzania, Uganda and Ethiopia to lead youth studies
- ABC-PABRA and IMARA TECH to develop labor saving technologies and ensure access to smallholders through mechanization service providers.

Capacity Development

Short-term programs trainees		Long-term programs trainees (All academic degrees including PhDs)	
90,045 Female	216,384 Male	**26** Female	45 Male

- Promoted Crop Network Groups (CNGs) to design crop product profiles in Africa for soybean, sorghum and millets, groundnut, and cowpea
- E-Learning portal (https://gldc.codeobia.com/) set up

Climate change

- Screened drought-tolerant GLDC crop varieties for intercropping to evaluate production and water use efficiency.
- Cropping system models were run to help bean breeding programs optimize Genotype × Environment × Management interactions.
- The use of wild relatives (wild *Phaseolus acutifolius*) to combat climate change highlighted.

Publications

80 peer-reviewed publications

85% ISI | **75%** Open Access | **>340** knowledge products

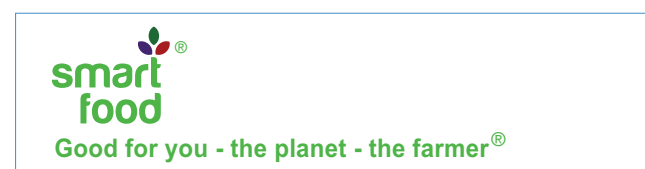List of publications

GLDC Annual Report 2019

Smart Food setup to be led by Africa and Asia with the formation of Smart Food Executive Council following signing of MoU by:

Trademark of the Smart Food logo and tagline approved and formally registered in India.

smart food
Good for you - the planet - the farmer®

Smart Food strengthened with three new ambassadors:

Dr Lalla Malika Issoufou
First Lady of Niger

Chef Anahita Dhondy

Chef Ranveer Brar

Who will join the other ambassadors based in London, Paris and Senegal:

Chef Mick Elysee

Chef Anto Cocagne

Chef Aistou M'Baye

Culinary blogger Dienaba Traore

Testing market acceptance and nutritional value of millets and pigeonpea

India: A pilot study with 1,500 school children (and 1,500 control group) showed significant increase in growth parameters (BMI and HAZ)* in comparison to control group for children fed millet-based meals compared to micronutrients fortified, rice-based meals. All millet-based meals were rated 4.5 or higher out of 5 for taste. This was launched by senior representatives of Government of India's NITI Aayog. Published in _Nutrients_ journal and _policies_ recommended.

Myanmar: A small pilot study showed that millets and pigeonpea meals had a positive impact on the extent of wasting and underweight children between 2-14 months; and sensory evaluations in the community showed on average 4 out of 5 for all recipes and products. Published in _Journal of Food and Agriculture_.

Protein study: Combinations of millets and legumes studied showed they made a complete protein and highly digestible protein with a basket of micronutrients. Published in _Cereal Chemistry_.

_____
* Body mass index (BMI); Height-for-age Z-scores (HAZ).

Photo: Liam Wright, ICRISAT

Communications at a glance

Project Syndicate THE WORLD'S OPINION PAGE
Goats Against Climate Change

THOMSON REUTERS FOUNDATION NEWS
As students map the weather, an Indian village bests its water woes

npr
Malnutrition Hits The Obese As Well As The Underfed

The New York Times
Grow Faster, Grow Stronger: Speed-Breeding Crops to Feed the Future

SciDevNet Bringing science & development together through news & analysis
Tailored, targeted AI apps pave way for smart farming

Radio Show in France with the three African Smart Food Ambassador Chefs.
rfi EMISSION 7 MILLIARDS DE VOISINS

THE HINDU
Genes of climate-resistant chickpea varieties identified

by Yemi Akinbamijo

Dr Yemi Akinbamijo's feature article in The Globe Post: _Superfoods can't save our broken system – But Smart Food can._

422 Total media mentions

160 Global & National

>30 media articles
Big Data 2019 Convention, ANH Academy Week 2019, UNCCD COP14 joint session, International Plant Protection Congress 2019 and Regional workshop on FAW management.

2019 › Social media

30,500 followers ▲ 30%

22,941 likes ▲ 16%

28,857 followers
Nearly doubled

A LinkedIn post on the World Day for Combating Desertification and Drought gathered the highest number of impressions – almost **90,000** – last year. A tweet at the conclusion of the Big Data in Agriculture Convention garnered **12,620** impressions – one of the highest ever. A tweet mentioning Bill Gates' reference to work done by CG centers was the top tweet in September with almost **10,000** impressions.

Campaigns on UN days, ANH Academy Week, UNCCD COP14, Africa Green Revolution Forum-AGRF, Global Commission on Adaptation report release, Global Science Conference on Climate-Smart Ag, Big Data in Agriculture 2019 Convention and International Plant Protection Congress.

**266** Total | **196** ISI publications | **296,217** Publication downloads

36 Books and book chapters | **8** Policy briefs

790 ICRISAT authors | **1037** NARS co-authors | **253** Happenings newsletter articles

Views **991,965** ▲ **7.8%**

Users **320,438** ▲ **5.1%**

Mobile engagement ▲**12**%

Happenings visitors ▲ **86**%

Maximum visitor engagement increase in **Mali - 25.71%**, followed by **Zimbabwe - 14.9%**

143 Design outputs

94 Photo and Video assignments

**Policy briefs and flyers on Natural Resource Management work in Ethiopia** - Impacts of the Yewol watershed project and successes in the Afar region. A poster was also developed. A decision guide was created on acid soil reclamation for use by both farmers and policymakers. **1,995** views on CG space with **1,010** downloads in the last six months.
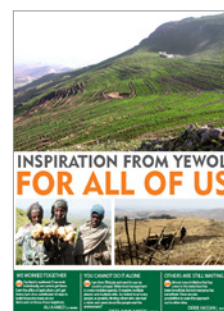
19,198 visitors in 488 groups visited ICRISAT headquarters in India.

4% | 10% | 11% | 75%

● Farmers ● Students ● Scientists ● Others
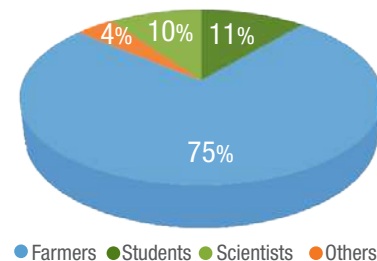
Inaugural Niger national millet fair by the Government of Niger.

Food display at the fair

At the African Green Revolution Forum (AGRF)

Smart Food Culinary Challenge organized with 58 student chefs from 16 culinary institutes across India.
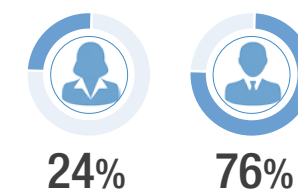
Our staff

999 People
27 Nationalities

India | **733** Mali | **64** Niger | **46** Malawi | **37** Zimbabwe | **27** Kenya | **21** Ethiopia | **16** Nigeria | **15** Uganda | **2**

Burkina Faso | **7** Mozambique | **6** Australia | **4** Germany | **3** Cameroon | **3** Rwanda | **2** United Kingdom | **1** Ireland | **1**

Benin | **2** Brazil | **1** Senegal | **1** USA | **1** Czech Republic | **1** South Africa | **1** Austria | **1** France | **1** Chad | **1** Belgium | **1**

Gender

24%   **76%**

Age

51+ years
41-50 years
31-40 years
Up to 30 years

ICRISAT Governing Board in 2019

Paco Sereme
Burkina Faso
Chair, ICRISAT GB

Trilochan Mohapatra
India
Vice Chair, ICRISAT GB

Sissel Rogne
Norway

Wendy Umberger
Australia

SK Joshi
India

Rachel K Chikwamba
Zimbabwe, upto Sep 2019

Prabhu Pingali
USA, from April 2019

Folasade Ogunde
Nigeria

Sanjay Agarwal
India

Laurie Tollefson
Canada

Peter Carberry
Australia
Director General
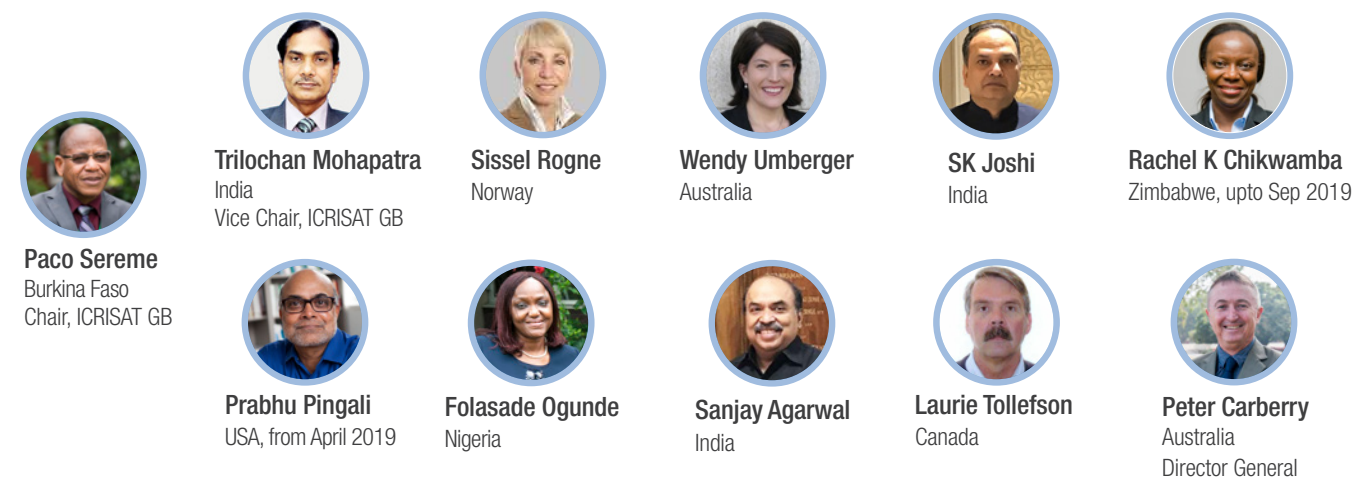
Projects

Contribution to grant revenue by project size
(in US$ thousands)

- **1%** | Small (<100)
- **5%** Medium (100-500)
- **94%** Large (>500)

▶ Financial summary

Top ten donors for 2019 (in US$ thousands)

Donor	Value
CGIAR	13,322
BMGF	11,238
India	11,185
USA	10,212
CGIAR CONSORTIUM	4,125
Ireland	1,775
GCDT	1,666
EU	1,654
CARE	907
Niger	710

▶ Partners
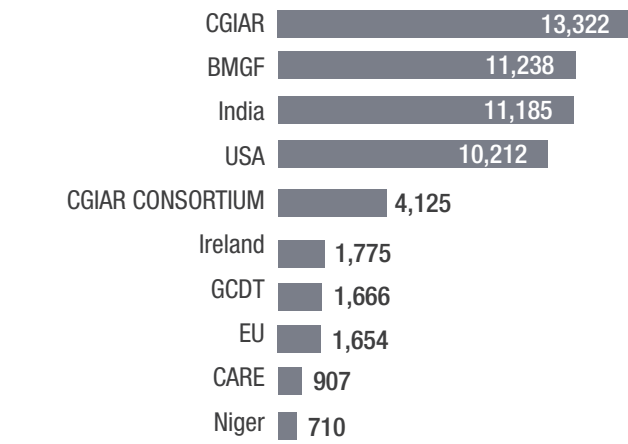
28 Academic	**13** CGIAR
5 Foundations	**3** International NGOs
44 Local NGOs	**11** Governments
13 Seed Companies	
33 Private Industries	**13** NARS
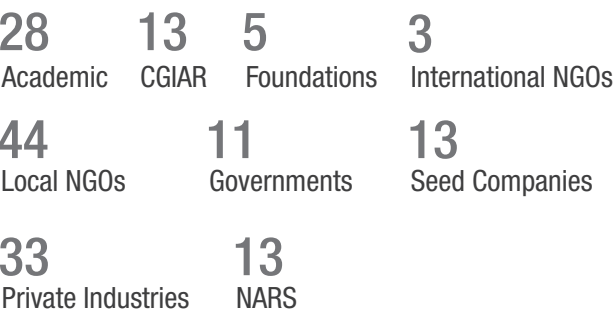
in US$ thousands

Balance Sheet	2019	2018
Assets		
Cash and Cash Equivalents	19,437	19,828
Investments	23,213	33,821
Accounts Receivable	20,160	15,756
Inventories	844	915
Prepaid Expenses	360	304
Property, Plant and Equipment	7,721	7,280
Other Assets	1,304	3,826
Total Assets	73,039	81,730
Liabilities		
Accounts Payable	13,154	9,850
Accruals and Provisions	1,442	1,531
Payments in advance from donors	20,751	28,916
Long-term Liabilities	439	546
Total Liabilities	35,786	40,843
Net Assets		
Unrestricted		
- Undesignated	8,916	12,426
- Designated	21,113	21,113
Temporary Net Assets - OCI	1,078	1,220
Permanently Restricted	6,146	6,128
Total Net Assets	37,253	40,887
Total Liabilities & Net Assets	73,039	81,730

ICRISAT Locations

New Delhi
HQ - Hyderabad, India
Bamako, Mali
Niamey, Niger
Kano, Nigeria
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About ICRISAT

ICRISAT
INTERNATIONAL CROPS RESEARCH
INSTITUTE FOR THE SEMI-ARID TROPICS

ICRISAT is a member of the
CGIAR System Organization

We **believe** all **people** have a **right** to **nutritious food** and a **better livelihood.**

ICRISAT works in agricultural research for development across the drylands of Africa and Asia, making farming profitable for smallholder farmers while reducing malnutrition and environmental degradation. We work across the entire value chain from developing new varieties to agribusiness and linking farmers to markets.

ICRISAT appreciates the support of CGIAR investors to help overcome poverty, malnutrition and environmental degradation in the harshest dryland regions of the world. See http://www.icrisat.org/icrisat-donors.htm for full list of donors.

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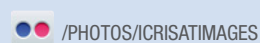Niamey, Niger
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