ICRISAT
Medium Term Plan
2021-2023

ICRISAT

INTERNATIONAL CROPS RESEARCH
INSTITUTE FOR THE SEMI-ARID TROPICS

Citation: ICRISAT Medium Term Plan 2021-2023. International Crops Research Institute for the Semi-Arid Tropics. Patancheru 502 324, Telangana, India. 100 pp

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Foreword

The year 2021 is unparalleled for ICRISAT, for two main reasons: First we are still in the throes of a pandemic that has upended the way we work, disrupted the lives of smallholder farmers whom we serve and clouded the future with uncertainty; second, we had to create an institutional Strategic Plan starting 2021, with less clarity than usual on what the future is going to look like.

To translate the overarching global vision and mission of ICRISAT into actionable items, the Governing Board approved the Strategic Plan 2021-2025. The Strategic Plan is a broad roadmap of the landscape ICRISAT will navigate over the next five years. However, the situation on the ground is shifting faster than ever before and a more granular document with short-term targets is needed to guide the organization and ensure we are focussed. This document is ICRISAT's Medium-Term Plan (MTP) 2021-2023.

The MTP encompasses research, research support and corporate support areas of ICRISAT. The research plan is designed around resilient and sustainable farm and food systems perspective which aligns with the UN Sustainable Development Goals. ICRISAT's new research strategy has identified climate variability, effect of climate change, malnutrition and land degradation as some of the issues needing special attention to bring about change. The MTP leverages our competitive advantage to strengthen the resilience of smallholder farmers and agri-food systems across the drylands. Research support units such as Farm & Engineering Services, the Crop Improvement Operations Team, Sequencing and Genotyping Services, and others provide the critical support required by the research teams. Corporate support areas including Finance, Human Resources, Communications, and others who play an important and enabling role for research teams to realise the vision and mission of ICRISAT.

The MTP follows a forward planning horizon of three years. This is a rolling plan which gives an opportunity every year to review and adjust the next three years' plans to consider the progress in science, shift in funding patterns, emerging threats and opportunities and the success achieved so far. The corporate support services will need to be modernised over time to support the research focus of ICRISAT. This annual review of our plans is also an opportunity to answer three strategic questions:

1. Should we do more of the same?
2. Should we do things differently?
3. Should we do different things?

The organizational MTP should be used to inform each individual staff member's annual work plans, and team- and department-level work plans. Creating a plan is only the first step. The next two are its execution and review. Everyone has a role in ensuring that the MTP is fulfilled by aligning their plans to the overall organisational plan. In the review phase, teams/departments determine how well they are adhering to the plan and evaluate whether any adjustments need to be made along the way to achieve the goals.

I thank all the staff members involved for the efforts they have put in to create this document that will chart the course forward for ICRISAT.

Jacqueline Hughes
Director General

Executive Summary

ICRISAT's focus is on smallholder farmers in the drylands of Africa and Asia who depend on rainfed or semi-irrigated farming and pastoralism for their livelihoods and provide close to half of the world's grain and livestock. The major challenges in the drylands are widespread poverty, hunger and malnutrition in tandem with water scarcity, land degradation, weak infrastructure, and gender inequality. Climate change is negatively impacting agriculture, leaving farming communities in these regions excessively vulnerable in the absence of appropriate technologies and risk management strategies. To fulfill our vision and mandate across the drylands, ICRISAT's research will be delivered through three integrated global research programs:

- Global Research Program on "Accelerated Crop Improvement" with the following targeted impacts:
  - Modernized crop improvement delivers high-yielding, abiotic and biotic stress-tolerant and more nutritious varieties to benefit smallholder farmers
  - High-yielding, market-preferred and adaptable crop varieties contribute to higher incomes, deliver better nutrition and improve the well-being of smallholder farmers in Africa and Asia
  - Significantly improved dietary quality of the poor in the drylands and beyond who cannot afford high-end processed foods or animal-based protein products; contributing to improved human health and reduced carbon footprint; alleviation of malnutrition, especially among women and children in the drylands of Africa and Asia and flourishing of small-scale village-based food processing enterprises.

- Global Research Program on "Resilient Farm and Food Systems" with the following targeted impacts:
  - Sustainable natural resource management from farm to landscape scale coupled with the adoption of context specific technologies and farming system diversification contribute to sustainable intensification, enhanced system resilience and food security and reduced land degradation in the drylands
  - Increased adaptation to climate variability and change through reduced greenhouse gas emission
  - Improved groundwater availability, enhanced cropping intensity and resource use efficiency and transformation of fragile landscapes into resilient production systems
  - Improved nutrition of rural and urban populations through greater consumption of diversified food
  - Farmers and traders benefit from greater competitiveness in markets, and rural youth and women find livelihoods as small- and medium-scale entrepreneurs.

- Global Research Program on "Enabling Systems Transformation" with the following targeted impacts:
  - Significant increase in environmental health through policy-induced changes in human behavior regarding mandate crops, particularly by scaling legumes as intercrops and crop rotation, contributing to enhanced systems resilience
  - Better access to markets to increase farmers' income and reduce poverty and better reach to markets to also improve nutritional security
  - Increased production of legumes to improve ecosystem services
  - Economic development through the strengthening of value chains and the development of micro-enterprises in rural areas. As a result of dietary changes, an improvement in human health, particularly of poor farmers and consumers, including men, women and youth living in precarious conditions is expected for different stakeholders.
  - Climate smart investments and incentives to enhance the resilience of value chains and food systems in the drylands.

The challenges of food and nutrition insecurity, poverty, gender inequality, climate change and environmental degradation in the drylands are interconnected. A mix of technical, socioeconomic, and institutional innovations is required to transform food and farming systems. These three dimensions are the basis of our impact pathways: (i) The technical impact pathway is delivered through the three global research programs; (ii) the socioeconomic impact pathway helps influence consumer behaviour, reshape markets and value chains and facilitate agribusiness innovations to enable the supply of healthy food from producers to consumers and create more jobs along the value chains and (iii) the institutional impact pathway supports the creation of policy frameworks and incentives that are needed to promote technology adoption, ecological intensification, market orientation and nutrition-sensitive value chain development.

ICRISAT's work will contribute directly to the achievement of the following UN Sustainable Development Goals: SDG 1 - No Poverty, SDG 2 - Zero Hunger and SDG - 13 Climate Action while also contributing to SDG 5.b - Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women and SDG 17.6 Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation.

Supporting the core research agenda of ICRISAT are the research support services and corporate support services. Working together in a coordinated manner, they enable the research teams to deliver on the portfolio of research projects in an efficient, effective and timely manner. The thrust is to deliver seamless, integrated support in a cost-effective and time-bound manner. To this end, support services are being modernized and digitized to enable 'anywhere' 'any time' delivery. The focus is also more on outcomes rather than outputs to create more agile and responsive support services.

ICRISAT turns 50 in 2022 and the International Year of Millets in 2023 are important landmark events in the MTP. These two occasions give us an unprecedented opportunity to highlight our work to a global audience and draw the world's attention to the problems and opportunities in the drylands. The way forward is clear. ICRISAT's leadership believes that the new opportunities that present themselves can and must be secured for a new and innovative ICRISAT.

Research Medium-Term Plan

1. Background

The world's population is projected to increase by 34% and reach 9.1 billion by the year 2050 (UN Population Division, 2011). More than half of this increase is expected to come from developing countries accompanied by rising incomes and increasing urbanization. To feed the burgeoning population, global food production will need to grow by 70% from the current level. The drylands are home to more than 2.1 billion people, 90% of whom live in low- and middle-income countries; 50% of this population living in poverty are resource poor and smallholder farmers. Apart from the arid lands the semi-arid and dry sub-humid regions in Asia and Africa are the major agro-ecologies of interest to ICRISAT. About 60% of the total arable land in South Asia is under dryland agriculture, while the corresponding figure for sub-Saharan Africa is around 70%. Both continents and their sub-regions share similarities in terms of climate, agro-ecologies and challenges and opportunities.

People in the drylands depend directly on rainfed or semi-irrigated farming and pastoralism for their livelihoods and provide around half of the world's grain and livestock. The major challenges in the drylands of Asia and Africa are widespread poverty, hunger and malnutrition in tandem with water scarcity, land degradation and gender inequality. Climate change processes are leading to increased water scarcity and declining crop yields, leaving the people in these regions excessively vulnerable in the absence of appropriate technologies and risk management strategies. The Millennium Ecosystem Assessment found that in general, the well-being of people in the drylands is lower than that of people in other ecological systems. For example, compared to other ecosystems, infant mortality rates are highest in the drylands and gross national product (GNP) per capita the lowest (www.fao.org). Globally, the burden of malnutrition in all its forms remains a challenge. According to current estimates, in 2019, 21.3% (144.0 million) of children under 5 years of age were stunted, 6.9% (47.0 million) wasted and 5.6% (38.3 million) overweight. An initial assessment by FAO suggests that the COVID-19 pandemic may have added between 83 and 132 million people to the total number of undernourished in the world during 2020 (FAO, 2020).

The Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) indicates that Africa and Asia, particularly the drylands, are at the highest risk from climate change impacts, given the magnitude of existing stresses in the continents (www.unccd.int). It is highly likely that in the coming years, significant areas of the drylands will see changing rainfall patterns with more frequent and intense extreme events such as droughts and floods. West Africa has undergone significant warming in recent decades which is going to intensify in the future regardless of the greenhouse gas (GHG) scenario. Globally, land degradation causes the annual loss of 75 billion tons of soil, equivalent to about US$ 400 billion per year, or approximately US$ 70 per person per year (www.grida.no). Nutrient depletion is another form of land degradation having severe economic impact at the global scale, especially in Africa. In Asia, nutrient loss by erosion causes an annual economic loss estimated at US$ 600 million and US$ 1,200 million is lost to soil fertility depletion (soils.usda.gov). Therefore, a mix of adaptation and mitigation strategies are key to managing climate risk and building resilient farm and food systems. At UNCCD COP13, countries have agreed on a new global roadmap to address land degradation. The new UNCCD 2018-2030 Strategic Framework is the most comprehensive global commitment to achieve Land Degradation Neutrality (LDN) in order to restore the productivity of vast swathes of degraded land, improve the livelihoods of more than 1.3 billion people and to reduce the impacts of drought on vulnerable populations (https://www.unccd.int/news-events/countries-agree-landmark-2030-strategy-save-fertile-lands)

Agriculture in dryland regions is beset with water scarcity and low productivity which coincide with widespread poverty and malnutrition. Defunct traditional rainwater harvesting systems, weak agropastoral system, inequities in the distribution of benefits derived from natural resources and the loss of various ecosystem services (declining base flow, deforestation and land degradation) are some of the reasons for the growing water scarcity, in addition to climate change-induced decrease and poor distribution of precipitation. Ineffective governance of and inadequate policy support to natural resource management in the drylands has exacerbated the situation. Mobilizing capital and knowledge to bounce back from this state is particularly challenging. While large areas are left fallow either in the rainy or post-rainy season because of water scarcity, considerable residual soil moisture is being lost as non-productive evaporation. Introducing sustainable water management technologies, soil moisture and nutrient monitoring tools along with establishing appropriate value chain linkages will help in crop intensification.

The dryland regions have traditionally been a major source of nutri-cereals such as millets and sorghum and protein-rich legumes with immense potential to contribute to nutritional security in these regions and beyond. However, poorly functional input and output markets and underdeveloped value chains are major factors that hinder tapping into the potential of these nutritious crops. Apart from a systemic approach to building the capacity of actors all along the value chain, especially farmers, women and youth, better infrastructure and improved governance of value chains supported by an enabling policy environment will be needed to achieve greater farmer participation in markets and value addition with objectives of increasing production, building resilience and increasing farm profitability. Also imperative is the harnessing of digital innovations that have high potential to connect and improve smallholder farmers' access to markets. A prosperous agriculture and food system will overcome the existing and emerging challenges. There is enormous scope for science-led innovations to unravel the distress of people in dryland areas.

Agricultural and food value chains in the drylands of Africa and Asia are mostly run by small and medium enterprises (SMEs) in logistics, wholesale and processing. The farmers, as well as the SMEs running short and long rural-urban value chains are subject to risks of human, plant and animal diseases and climate shocks. In the past, there has been little focus on SMEs that serve as a bridge connecting smallholder producers to consumers. This has led to inefficiencies and exclusion, underlining the need to recognize them as a key focus area in value chain research supporting dryland farm and food systems transformation. There is evidence that farmers' collectives such as farmer producer organizations (FPOs) and farmer producer companies (FPCs) could play a key role in enhancing the participation of smallholder farmers and improving agricultural value chains in dryland regions. Inclusive, competitive and sustainable business models, which focus on inclusion of marginalized groups (especially women and youth); strengthening the bargaining power of smallholders, for instance through innovative institutions, and improving their linkages with the private sector and markets, are needed to increase their participation in the value chains.

Despite the important role women play in dryland agriculture, they rarely have ownership of or control over the land they cultivate and manage. Their lack of assets means they cannot secure subsidized agricultural inputs, credit or extension services, making the land they cultivate less productive and profitable compared to those of male farmers. Increasing job insecurity, the drudgery of agricultural work done for relatively lower earnings than men and growing food insecurity are other obstacles they encounter. Women's disadvantages vis-à-vis men in terms of education, lack of investible capital, partial or inadequate knowledge of mechanization technologies, the lack of agricultural and extension services that specifically include or target women farmers and tenure insecurity are some of the reasons for this inequality.

Almost 90% of the world's youth live in developing countries. Globally, the youth unemployment rate is three times higher than that for adults, and even more so in the rural drylands where harsh working conditions and the lack of opportunities are very common. Youth in the drylands lack important skills and access to resources to be competitive in labor markets, be that at home in rural villages or in big urbanized areas and cities. As disillusionment sets in and hopes of a better future and a decent life wane, the world loses a generation of potential innovators, transformational leaders, hardworking talent and inspiring community members. Empowering this substantial chunk of the population with real opportunities and skills can empower them to make critical contributions to solving many of today's global challenges, such as unemployment, climate change impacts, food insecurity and poverty in their home countries. That young people are shunning farming is also a concern for the future of agriculture and food security in the drylands. Engaging these catalysts of change can help accelerate the impacts of agricultural development outcomes. This can happen by conducting strategic research on youth and agriculture, building human capacity, providing youth-friendly financial services, life skills and behavior change training, enabling access to affordable technology, stimulating entrepreneurship and employment, addressing socio-cultural barriers, building youth-friendly social capital and strengthening local institutions. Youth are quick learners and users of digital and disruptive technologies. Enabling their participation in these technologies will significantly contribute to transforming agriculture in the drylands.

ICRISAT's mandate crops (sorghum, pearl millet, finger millet, chickpea, pigeon pea and groundnut) have an important role in farming to achieve food and nutritional security in the drylands. These crops can adapt to poor soils, adverse climatic conditions and low water availability, conditions frequently prevalent in the drylands. Products made from these mandate crops have use in the dryland regions and are consumed globally. Legumes such as groundnut, chickpea and pigeonpea have an added advantage as they can also be cultivated in high rainfall, rainfed and irrigated regions in an intensive cultivation system. ICRISAT's crop commodities are also health and nutritive

food and used for feed too. Livestock is one of the most stable and important components of smallholder dryland farming systems in Asia and Africa and contributes substantially to household livelihood and nutrition. Globally, the livestock sector is growing rapidly (Ojiewo et al., 2020). In Africa, farmers keep livestock as part of pastoral and agro-pastoral farming systems. But in South Asia, small-scale mixed crop-livestock farming is common and indeed the dominant form of production system. Promoting agroforestry in the drylands will not only support livestock but also help reduce soil erosion, water erosion, increase incomes and help farms adapt to future shifts in climate by supporting various production and ecological ecosystem services, which increase farmland resilience to climate change (www.vslp.org). In developed countries, the livestock sector is a highly commercial business and needs huge quantities of feed.

The genetic resources of ICRISAT's mandate crops conserved in the ICRISAT Genebank could be of immense importance, especially as sources of native genes conditioning resistance to various biotic and abiotic stresses that can serve as unique study materials to understand the mechanism of adaptation to abiotic stresses. They are also an excellent genomic resource to isolate candidate genes for tolerance to climatic and edaphic stresses to accelerate genetic gains. ICRISAT houses one of the world's largest genebanks with a collection of over 128,000 accessions of millets and legumes at its headquarters in Hyderabad, with regional genebanks in its hubs in Eastern and Southern Africa (ESA) and West and Central Africa (WCA). However, only a very small fraction of these accessions has been utilized so far because of operational difficulties in dealing with large number of germplasm accessions.

Low seed replacement in farmers' fields is a major limitation to be addressed by enhancing access to quality seeds to increase productivity in the drylands. Seed systems, which are at the heart of smallholder farming systems' productivity improvement in developing countries largely works through formal and informal channels. In the dryland areas, the situation is worse because of the low public and private investments in dryland crops. Quality production and effective delivery mechanisms of improved seeds to smallholder farmers in different agro-ecologies across the drylands is lacking. Limited capacity for the sustainable supply of early generation improved seeds leads to limited certified seed production and supply, resulting in lower productivity and low farm incomes. Due to the lack of demand from resource poor smallholders and the absence of an enabling policy environment and infrastructure, many seed enterprises have sub-optimal marginal returns on their investments, serving as a deterrent for the formal seed sector to include dryland crops in their portfolio and consequently hindering the availability of quality seed of the dryland crops to smallholder farmers. Weak extension systems, unfavorable policies and underdeveloped value chains too have limited the adoption of new varieties and accompanying technologies, limited use of quality inputs (seed and fertilizer), which in turn lead to low market demand (Gebeyehu et al. 2019). The policy biases promoting the big three – rice, maize and wheat – and influencing consumption habits and market demand that adversely impact the markets for dryland crops, need to be analyzed and corrected.

While the COVID-19 pandemic rages on, ICRISAT continues to ensure that farmers in the dryland regions have access to seed of new varieties and new cultivation technologies while at the same time its researchers in Asia and Africa strive to fulfil targeted research deliverables. This medium-term plan confirms ICRISAT's commitment to implementing its five-year Strategic Plan 2021-2025 to the best of its abilities and with least disturbance under the fragile COVID-19 environment.

ICRISAT continues to be a CGIAR center but has decided not to join the new One CGIAR Governance. In the new arrangement ICRISAT will endeavor to work closely with One CGIAR as a research partner, and at the same time continue to establish itself as the prime institute devoted to research in the dryland areas. It has increased responsibility to ensure that the innovation needs and demands of smallholder farmers practising agriculture in the drylands and faced with comparatively higher degree of adverse climatic, land degradation, resource and market governance challenges and high market risks are supported through co-development of appropriate technologies, innovations, training and capacity strengthening. Under the new arrangement, ICRISAT will need to develop new partnerships and generate more resources. Meanwhile, it will expand its research-for-development efforts to co-create innovations and technologies that support smallholder resource-poor farmers and in transitioning to sustainable farming and food systems while ensuring it maintains environmental integrity by avoiding pollution, biodiversity loss and land degradation in the drylands.

ICRISAT's MTP 2021-23 is designed to align with ICRISAT's Strategic Plan 2021-25 to support the transition of dryland farming to sustainable and nutritious farming and food systems while protecting the environment in Asia and Africa. The MTP will enable scientists to effectively utilize genetic resources and genomics tools to design

better crop improvement strategies combining foundation and translational research to develop nutritious, climate resilient crop varieties; sustainable agricultural production system innovations to effectively manage land, soil and water; develop inclusive and resilient value chains and linkages to markets and create new opportunities for women and youth in agriculture through capacity strengthening that will contribute to increased incomes and empowerment.

2. Highlights of the Research Portfolio

The MTP 2021-23 is based on ICRISAT's ability to move forward by transforming its approach of undertaking science of discovery to science of delivery through a structured mechanism that combines foundation research and translational research to deliver global public goods for the drylands. At the same time, it aims to develop improved products, technologies, practices and policies through local adaptive research with national and regional stakeholders and partners from the public and private sector to deliver outcomes and impact at scale for smallholder farmers and consumers. ICRISAT's strength lies in its ability to analyze key problems and opportunities in the areas of crop improvement, seed systems, soil health-water management, crop-livestock diversification, integrated crop management, climate risk management, value chain development, enabling policies and facilitating market access in order to drive innovations for development from laboratory to farm to landscape level with the objective of increasing farmers' income, nutrition and resilience of farming and food systems in the drylands.

Given that ICRISAT operates across Asia and Africa, there are differences in the operating framework, for example, differences in:

- Farming systems: Africa – mixed cropping of cereals and legumes vs Asia – mainly monocropping
- Mechanization and commercialization: Africa – often smallholder subsistence-dominated farming systems vs Asia – smallholders have better access to mechanization and input-output markets.
- Governance: Africa – many countries have states that are unable to support major investments in agriculture vs Asia – governments intervene through policies, subsidies and major investments at state and federal levels.
- Donor investment: Africa – many countries rely on significant donor investment to support basic programs vs Asia – donor investment is minor compared to national budgets and more likely in the form of loans (ADB, IFAD, World Bank).

The R4D programs are implemented considering these differences. In many cases the different geographies provide the opportunity to exchange innovations and approaches, such as multi-stakeholder engagement approaches, appropriate mechanization, agri-tech and agribusiness connections. The research programs under MTP will be aligned to facilitate such exchanges.

The MTP 2021-23 is guided by ICRISAT's recently approved Strategic Plan 2021-25 and embraces a sustainable farm and food systems perspective aligns with and contributes to the UN Sustainable Development Goals (SDGs). ICRISAT's new strategy has identified environmental variability, effect of climate change, malnutrition and land degradation as some of the issues needing special attention to bring about change. The MTP 2021-23 melds our mandate's comparative advantage that encompasses both crops and the dryland ecology with our ability to strengthen the resilience of smallholder farmers and agri-food systems across the dryland areas. Behind ICRISAT's legitimate responsibility for the drylands of Africa and Asia is its vast experience and successes in the regions. This natural connection between the two main regional ecologies of ICRISAT's mandate enhances opportunities for sustainable agricultural intensification, employment, and greater adaptation to climate change by integrating, drawing together and streamlining technologies and global partnerships and networks. The research activities elucidated in the MTP 2021-23 will be built in within the following three global research programs to be implemented in Asia, ESA and WCA:

- Global Research Program on "Accelerated crop improvement of highly nutritious legumes and cereals food in the drylands by enhancing the genetic gains" (Accelerated Crop Improvement)
- Global Research Program on "Towards inclusive and resilient farm and food systems for nutrition in the drylands" (Resilient Farm and Food Systems)
- Global Research Program on "Enabling transformations through improving policies, facilitating institutional innovations, markets, and scaling impacts and capacity development to support sustained reduction in poverty and malnutrition in the the drylands" (Enabling Systems Transformation).

The research portfolios of the three global programs will include combinations of foundation research, translational research, local adaptive research as well as scaling for impact. The three global research programs are integrated to create impact at scale. Very few advanced research institutes are engaged in the generation of basic knowledge on crops and constraints in dryland areas to address their low yield potential and to reduce losses due to changing climate and soil health deterioration. Hence, together with them, ICRISAT engages in conducting foundation research to generate basic knowledge in the area of genomics, molecular biology, nutrition, industrial use, climate resilience and soil health and uses the generated knowledge in translational research in trait breeding, crop breeding and soil health improvement to develop better crop varieties with enhanced yield potential that can reduce yield gaps. The international public goods (IPGs) developed through translational research shall be evaluated, demonstrated and refined to suit local needs together with stakeholders and thereafter scaled up for impact together with governments and other stakeholders. The research activities in the three global research programs are focused on a development continuum aimed at transitioning the drylands of Africa and Asia to sustainable and resilient farm and food systems. The programs envision impacts to achieve nutrition and food security; poverty reduction, livelihoods and jobs; gender equality, youth and social inclusion; climate adaptation and greenhouse gas reduction; environmental health and biodiversity through global partnerships working with a number of stakeholders in the drylands.

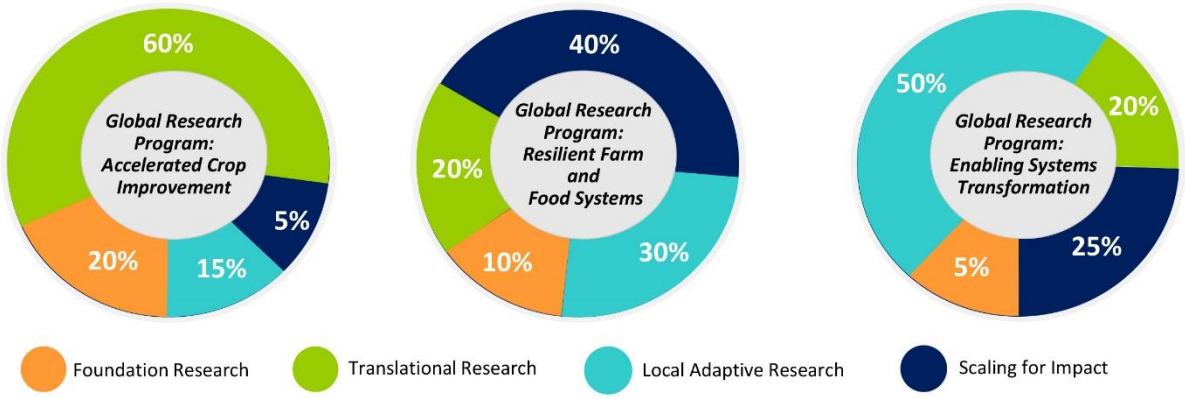


Figure 1: The share of Foundation, Translational, Local Adaptive and Scaling for Impact research in the three Global Research Programs in the Medium-Term Plan 2021-23.

The Global Research Program on Accelerated Crop Improvement will focus on developing improved cultivars for accelerated yield increase and quick access of quality seed of improved varieties to farmers by means of improved seed systems enabled by the increased use of genomic and breeding technologies developed at ICRISAT and elsewhere. The program has region-specific agronomic and breeding targets to accelerate genetic gains for both food and feed. ICRISAT's mandate crops sorghum and pearl millet fit both fodder and feed needs of livestock which are essential to farmers in the drylands. This will accelerate demand for livestock products and consequently the importance of fodder crops. For example, though sorghum and pearl millet are not grown in Punjab, India, they come from other states to feed their animals and poultry.

ICRISAT will use its large crop gene pool to develop new genetic resources to be shared with global research institutes and NARS partners. It will also be used to develop genomic tools to ensure the use of most efficient and effective solutions in crop improvement, particularly promoting the use of rich genetic resources for crop improvement, while conserving our mandated genetic resources for future generations. The program aims to deliver improved germplasm to public and private partners with a focus on nutrition, biotic and abiotic stresses and market-driven traits that meet the needs of the dryland farmers. Besides its focus on crop improvement, the program will facilitate the testing of improved varieties under typical environmental conditions faced by farmers in the drylands. The program will embrace frontier science tools such as genome editing to resolve some of the intractable challenges in agriculture and gene mapping and bioinformatics to identify new genes to break yield barriers, improve nutrition and address biotic and abiotic stresses. The MTP 2021-23 provides opportunities to implement the Breeding Program Assessment Tools (BPAT) recommendations to modernize its breeding strategy; mechanize its breeding operations; make better selection decisions through better statistical designs and standardized testing that lead to increased heritability; implement better data management practices that culminate in higher genetic gains in terms of increased yield potential, resistance/tolerance to biotic and abiotic stresses and climate resilience.

This shall be achieved through targeted product concept-based product profile breeding for targeted markets, improved breeding strategies including the use of genomic information, markers and improved mechanized operations (see annexure 1 for facilities and tools) as well as the ability to quickly advance generations using Rapid Generation Advancement (RGA) protocols developed at ICRISAT.

The Global Research Program on Resilient Farm and Food System shall focus on innovations to adapt and mitigate the impacts of climate change and variability on smallholder agriculture and rural livelihoods. The program addresses the critical issues of water management and land degradation in the drylands. Increasing productivity for food, feed, diversification of the farm with livestock and agroforestry will be promoted for increased incomes, enhanced sustainability and greater climate resilience. The program is built on ICRISAT's successes in integrated watershed management and soil health improvement that are being sought by our partners for scaling up and out. Our role is to facilitate and backstop sustainable land and water management efforts by partners and contribute to strategic knowledge generation to develop context specific solutions; this is where ICRISAT has a comparative advantage. The program will undertake research on geospatial and remote sensing to be able to map areas for different uses, provide information on the deployment of appropriate crops and varieties in different regions based on soil moisture availability while at the same time estimating yield and yield losses. The program shall collaborate with a range of agri-tech start-ups to provide digital solutions across the value chains to build resilience. The rapid advancement of digital solutions has the potential to enable a large number of farmers, rural communities and other value chain actors to access information, credit, inputs and markets in a cost-effective manner. We continue to enhance our program portfolio on Digital agriculture by providing need-based digital advisory tools as a source of information and decision support systems for different stakeholders.

The Global Research Program on Enabling Systems Transformation aims at enabling farm and food systems transformations by improving policies and facilitating innovations, markets and capacity development by leveraging the Global Research Programs on Accelerated Crop Improvement and Resilient Farm and Food systems. The Program will support ICRISAT in developing demand driven, more sustainable, profitable and nutrition sensitive agricultural technologies and management practices, which are adopted widely. It shall also focus on the development of appropriate institutions, policies and governance processes to create conditions conducive for the uptake of technologies and innovations and markets for prosperous drylands. Capitalizing on rapid urbanization and creating fair and sustainable rural-urban food linkages to spur demand for ICRISAT's mandate crops will also be its focus area. The program will promote Smart Food with the objective of diversifying staples – not with any food – but those that fit the criteria of being good for the individual, good for the planet and good for the farmers/consumers. ICRISAT's crops can be essential components of Smart Food for a majority of farmers and consumers not only in the dryland regions but globally as well. The program provides strategic research inputs into ICRISAT's research priority setting, tracking adoption and dis-adoption of modern technologies and impact assessment using robust research methods. It adopts a systemic approach to building the capacity of value chain actors, especially farmers, SMEs, entrepreneurs, the infrastructure and improved governance of value chains for greater farmer participation in markets, value creation, resilience and farm profitability. It will identify agri-nutrition linkages and incentives along value chains (supply, demand, markets and pricing) and policies to initiate a shift towards nutritious ICRISAT crops. It aims to co-develop decision support tools for policymakers and other stakeholders including FPOs, SMEs, R & D actors and communities to guide transitions to sustainable farm and food systems. The dietary and nutritional interventions targeted in the program promote knowledge about nutrition as well as demand for Smart Food in the targeted geographies/ecologies. The role of gender, marginalized groups, women and youth will be central in all research activities and cut across all Research Programs. The program will develop and design inclusive value chains and enhance farmers' collective bargaining power by promoting the setting up of FPOs/self-help groups (SHGs). It shall support the growth of agri-biotech/food start-ups and agribusinesses operating across the agricultural value chain through incubation that can contribute to entrepreneurial and self-employment opportunities for local women and youth. The program also aims at generating innovative processed products that promote smallholder dietary diversity and nutrition intake. Ultimately, the IPGs generated through diverse research interventions will be disseminated through appropriate knowledge management platforms and capacity building activities.

Between 2021 and 2023 lie two important milestones for ICRISAT – its 50th year of establishment on March 28, 2022 and the United Nations International Year of Millets in 2023. The official ICRISAT birthday and launch of its 50th anniversary falls on 28 March 2022. This is a great opportunity for ICRISAT to celebrate its successes, partnerships and contributions towards helping millions of farmers in the drylands improve their livelihoods and also a time to refocus its objectives under the changing and uncertain scenario the world is facing. The 50th anniversary

will be celebrated with special events at headquarters and in the regions. The unanimous approval by the United Nations General Assembly of the resolution sponsored by India with the backing of 70 countries, to declare 2023 as the International Year of Millets is a welcome step towards resurrecting these nutrient-dense and climate change-resilient food crops. This paves the way for the development of new market opportunities for millet grains, millet foods and enables farmers and consumers to benefit from this strengthened value chain. The interventions and learnings in this endeavour can significantly benefit the global south. ICRISAT will organize a number of events together with the Government of India, the State Government of Telangana, public-private sector institutions, NGOs and other partners at headquarters and, in other countries of Asia, Eastern and Southern Africa and West and Central Africa.

Research programs have the responsibility of ensuring uptake of their innovations. This should be integrated into the projects and longer-term planning. In this regard, the Research Programs will leverage the institute's communications skills and resources, integrating these into projects to contribute to the uptake. Research Programs also have a role to play in contributing to the broader communication of ICRISAT's work and impacts. Researchers will work with the institute's Communications team, proactively contributing information that can be used for promoting and positioning ICRISAT. Scientists too will play a proactive role in representing the institute at local and global events. Key strategic events will be selected for additional engagement, e.g. the UN Food System Summit, UN Climate Change Conference (COP) and GLF Drylands conference. Additional efforts will be made for ICRISAT's 50th anniversary in 2022, contributing to the institute's events and promotions. The following year, 2023, will be the UN International Year of Millets, an opportunity to bring attention to the value of some of ICRISAT's mandate crops, highlight the work of ICRISAT and identify research needs for additional fundraising efforts. The UN International Year of Millets will be integrated into all relevant proposals.

ICRISAT has decided to create its own signature output to strengthen its position as a premier drylands institute. This will represent the 'state of the drylands'. The document will contain data and information that can be used as a key resource and be regularly quoted. It is expected that this will evolve over time and build the reputation of ICRISAT. The scientists and communications team will work together to produce a high quality and visually attractive output.

3. MTP Programs Portfolio

Global Research Program: Accelerated crop improvement of highly nutritious legumes and cereals food in the drylands by enhancing the genetic gains

Program Overview and Rationale

This Global Program aims at enhancing diversity, productivity, production, nutrition quality and profitability of grain legumes and cereals in the drylands of the world using modern germplasm conservation and improvement approaches. The major constraints facing crop improvement programs today are the rapid decrease in agricultural land, depletion of ground water, increased incidence of extreme rainfall events, increasing temperatures, emergence of new pest and diseases and limited genetic base of cultivars that hinder the production of grain legumes and dryland cereals under climate crisis. This is the right time to adopt sustainable approaches to crop improvement of these crops in order to produce more yield per unit of land, water, and time and within environmental limits. There is a need to accelerate genetic gains in dryland legumes and cereals as these geographies are prone to poverty, malnutrition and climate change impacts. Therefore, this Global Research Program shall adopt an interdisciplinary approach to address three of the Sustainable Development Goals – no poverty, zero hunger and good health and wellbeing; and achieve food security, improved nutrition and promote sustainable agriculture.

The program is built on ~50 years of ICRISAT's experience in the drylands and innovation capacities developed in agri-food systems of legume and cereal crops. ICRISAT's crops that include both dryland cereals (sorghum, pearl millet and finger millet) and grain legumes (chickpea, pigeon pea and groundnut) are grown, consumed and traded in the drylands and have the potential to address key challenges in the area of health and nutrition as they are rich in protein, micronutrients, fiber and essential amino acids. The program will work on the genetic improvement of these crops together with ICRISAT's Global Research Programs on Resilient Farm and Food Systems and Enabling Systems Transformation to deliver climate resilience, poverty reduction, nutritional security and environmental

sustainability in the drylands. In order to achieve accelerated development, the program's research areas are prioritized based on the requirements of key traits, research investment, food quality and safety, markets and in alignment with stakeholder needs.

This program aims to develop climate resilient, high-yielding and more nutritious crop varieties with broader genetic base and to facilitate access to seeds of these improved varieties to smallholder farmers through formal and informal systems. To achieve this, the program shall use germplasm conserved in the ICRISAT genebank and multi-disciplinary approaches of crop improvement through seven targeted outputs. For instance, the program plans to conserve, characterize and promote the use of germplasm for crop improvement utilizing modern genomics approaches to understand genome architecture, characterize germplasm, identify candidate genes/ genomic regions and enhance precision and efficiency of crop improvement programs. To address intractable and future value-added traits, biotechnology platforms such as gene editing, genetic engineering and enabling technology platforms such as speed breeding will be developed. Given that ICRISAT's mandate crops are grown in marginal environments where they are exposed to several abiotic and biotic stresses, a range of crop phenotyping platforms for assaying biotic stresses, abiotic stresses and nutrition have been planned. Using germplasm from the genebank, breeding programs together with crop phenotyping and genotyping platforms will provide molecular and genetic basis for stress adaptation, nutritional quality and also sources for resistance and tolerance to biotic and abiotic stresses. The program plans to modernize crop improvement programs at ICRISAT and for its national partners by using multi-disciplinary approaches and by also enhancing operational efficiency. Once climate resilient, high-yielding and more nutritious crop varieties with a broader genetic base are developed, access to their affordable seed by smallholder farmers in a timely manner will be facilitated by developing innovative models of early generation seed (EGS) and certified/QDS seed production. Efforts will be made to strengthen the technical and business capacity of public and private seed enterprises for profitable targeting of seed production and supply. The program will work closely with the other Global Research Programs to create an enabling policy and institutional environment and for the large-scale adaptation of improved cultivars into farming systems. In the process, women and youth-friendly seed business models and digital tools will be developed and promoted.

Alignment with SDGs: 1 (No Poverty), 2 (Zero Hunger), and 13 (Climate Action) while contributing to 5.b (Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women) and 17.6 (Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation).

Output Targets

- Conservation and utilization of the biodiversity of ICRISAT's mandate crops for current and future generations
- Understand genome architecture, development and deployment of genomic/bioinformatics resources and tools for pre-breeding and modernization of crop improvement
- Enable accelerated delivery of technologies and cutting-edge innovations in biotechnology for future traits
- System analysis and phenomics to accelerate the development of crop products with enhanced environmental fitness, nutrition and marketability that increase their adoption by target smallholder farming communities and enhance their economic well-being and health
- Biotic stress resistance and management options that raise the productivity of mandate crops under smallholder farming systems
- Information on nutrition research in genomics, breeding and agronomy together with improved nutrition-rich germplasm made available to farmers
- Delivering high-yielding, climate resilient, nutrition dense and market-preferred varieties and hybrids
- Sustainable and timely access to quality seed of high-yielding, market-informed varieties of drought-tolerant and nutritious crops at affordable prices
- Women and youth engagement with advanced technologies.

Outcomes

- Better varietal development decisions based on the need of the targeted regions and value chain drivers integrated into the breeding programs
- Demand-driven traits of future varieties made available to farmers in Asia, ESA and WCA; increased yield of pigeonpea, chickpea, groundnut, sorghum, pearl millet and finger millet harvested by farmers

- Climate change effect on diseases-insects better predicted; durable resistance sources identified from germplasm to use in crop improvement programs and better integrated pest management practices available to the community, including breeders and farmers
- Modernized breeding programs with the ability to deliver higher genetic gains
- Strengthened formal and informal seed systems for cereals and legumes in dryland areas with different stakeholders connected on a digital platform, ensuring timely access of quality seed to farmers
- Increased income, nutrition and resilience
- Reduced rural poverty
- Strengthened capacity of partners and stakeholders.

Impacts

- Modernized crop improvement delivers high-yielding, abiotic and biotic stress-tolerant and more nutritious varieties to benefit smallholder farmers in Africa and Asia
- High-yielding, market-preferred and adaptable crop varieties contribute to higher incomes, deliver better nutrition and improve the well-being of smallholder farmers in Africa and Asia
- Significantly improved dietary quality of the poor in the drylands and beyond who cannot afford high-end processed foods or animal-based protein products; contributing to improved human health and reduced carbon footprint; alleviation of malnutrition, especially among women and children in Africa and Asia and flourishing of small-scale village-based food processing enterprises.

Logical Framework of Global Research Program: Accelerated Crop Improvement: Major outputs, intended users, outcomes and impacts

	Output Targets	Intended users	Outcomes	Impacts
Global Program: Accelerated crop Improvement of highly nutritious legumes and cereals food in the drylands by enhancing the genetic gains				
Output 1. Sustaining and utilizing the biodiversity of ICRISAT mandate crops for current and future generations				
Output 1.1. Germplasm of 11 crops properly conserved, viable, healthy and available for distribution as per ITPGRFA to partners and users worldwide, including new collected germplasm				
2021	At least 90% of the in-trust materials of all crops available for distribution as per ITPGRFA standards	ICRISAT, CGIAR, ARIs, NARS, universities, the private sector and farmers	ICRISAT germplasm being used to develop climate resilient, high-yielding and nutrient-dense varieties	High-yielding and adaptable crop varieties contributing to higher incomes, delivering better nutrition and improving the well-being of smallholder farmers in Africa and Asia
2022	More than 90% of the in-trust materials of all crops available for distribution as per ITPGRFA standards			
2023	More than 95% of the in-trust materials of all crops available for distribution as per ITPGRFA standards			
Output 1.2. Germplasm characterized, multiple thematic sets developed and associated information made available through a user-friendly database to multiple partners and users worldwide				
2021	At least 90% of the in-trust materials of 11 crops characterized (crop descriptors)	ICRISAT, CGIAR, ARIs, NARS, universities, the private sector and farmers	Germplasm characterization data and thematic subsets being used to advance research and develop better lines with enhanced genetic	Improved germplasm with enhanced genetic diversity and superior traits contributing to sustainable agriculture and
	At least 5,000 accessions phenotyped and genotyped to develop multiple thematic subsets for five crops			
2022	More than 90% of the in-trust materials of all crops characterized (crop descriptors)			

	*At least 10,000 accessions phenotyped to develop multiple thematic subsets for five crops		diversity in crop improvement	improving the well-being of farmers in Africa and Asia
2023	More than 95% of the in-trust materials of all crops characterized (crop descriptors)			
	*At least 15,000 accessions phenotyped to develop multiple thematic subsets for five crops			
Output 1.3. New accessions collected in multiple countries in partnership with NARS based on gap analysis				
2021	Collection of germplasm in Chad, Niger and Mauritania conducted	ICRISAT, CGIAR, ARIs, NARS, universities, the private sector and farmers	Genetic diversity of mandate crops enhanced and available to multiple users	Improved germplasm with enhanced genetic diversity and superior traits contributing to sustainable agriculture and improving the well-being of farmers in Africa and Asia
2022	New countries prospected and agreements signed			
	Materials collected in previous year sent to India			
2023	New countries prospected and agreements signed			
	Materials collected in previous years sent to India			
Output 2. Understanding genome architecture, development and deployment of genomic/bioinformatics resources and tools for pre-breeding and modernization of crop improvement				
Output 2.1. Genotyping and bioinformatics platforms, tools and technologies established				
2021	Genome assemblies improved using new sequencing technologies and novel bioinformatics pipelines optimized for trait discovery	ICRISAT, CGIAR, ARIs, NARS, universities and the private sector	User-friendly genotyping platforms, tools and technologies enhance the efficiency of crop improvement programs Strengthened capacity of stakeholders	Crop improvement programs modernized and delivering improved varieties with higher yield and preferred traits in Africa and Asia
2022	*Germplasm diversity catalogued and pan genomes developed. Novel bioinformatics pipelines optimized for trait discovery and genomic databases developed.			
2023	Novel bioinformatics pipeline es optimized for trait discovery and genomic databases developed			
Output 2.2. Marker traits associations established and validated using forward/ reverse genetics, systems biology and other omics technologies				
2021	Genomic regions, genes, haplotypes and markers associated with target traits identified	ICRISAT, CGIAR, ARIs, NARS, universities and the private sector	Markers associated with target traits enhanced the selection efficiency of crop improvement programs Strengthened capacity of stakeholders	Crop improvement programs modernized and delivering improved varieties with higher yield and preferred traits in Africa and Asia
2022	Genomic regions, genes, haplotypes and markers associated with target traits updated and validated			
2023	Genomic regions, genes, haplotypes and markers associated with target traits updated and validated			
Output 2.3. Trait introgression pipeline optimized and utilized to develop improved lines				
2021	Trait introgression pipeline, markers-assisted back-crossing (MABC) and haplotype-based breeding (HBB) optimized	ICRISAT, CGIAR, ARIs, NARS, universities and the private sector	Integration of advanced genomics-assisted breeding and pre-breeding approaches enhanced precision and efficiency of crop improvement programs	Crop improvement programs modernized and delivering improved varieties with higher yield and preferred traits in Africa and Asia
	Genomic prediction model established (with Crop Breeding and Data Management & Analytical Support)			
2022	Trait introgression pipeline –Wide hybridization (WH), Forward Breeding, MABC and HBB validated			

	*Genomic prediction model validated (with Crop Breeding and Data Management & Analytical Support), and advanced and new genomics-assisted breeding methodologies explored and optimized			
2023	WH, FB, MABC and HBB deployed in crop improvement			
	*Genomic selection integrated in crop improvement *at reduced scale			
Output 3. Enabling accelerated delivery of technologies and cutting-edge innovations in biotechnology for future traits				
Output 3.1. Trait engineering platform established				
2021	A universal leaf-based high throughput delivery system for CRISPR developed in dryland cereals and grain legumes for next generation gene editing applications	ICRISAT and national institutes	Utilization of trait engineering platforms enhance the adoption of novel breeding technologies in crop improvement	Improved varieties for intractable and future value-added traits grown by farmers for higher productivity and better markets in Africa and Asia
2022	Enabling tools and platform technologies for precision genetic and genome engineering technologies established to achieve novel trait enhancement pipelines			
2023	Forward and reverse genetic tools and resources established to identify and validate causal genes for game changing traits based on crop product profiles			
Output 3.2. Key breeding and market traits engineered in cereal crops				
2021	Elite alleles for Striga resistance, low hydrogen cyanide (HCN) and reduced rancidity identified	ICRISAT, CGIAR, ARIs, NARS, universities and the private sector	Accelerated development of cereal varieties/hybrids with future traits	Improved cereal crop varieties for intractable and future value-added traits grown by farmers for higher productivity and better markets in Africa and Asia
2022	Causal genes/alleles for rancidity trait identified for gene editing in pearl millet			
2023	Enabling precision genetic technology developed to improve sorghum for forage and pearl millet for Striga resistance and increased flour shelf life			
Output 3.3. Key breeding and nutrition traits engineered in legume crops				
2021	Elite causal alleles for mainstream traits such as protein quality and photoperiod sensitivity in chickpea and pigeonpea identified	ICRISAT, CGIAR, ARIs, NARS, universities and the private sector	Accelerated development of legume varieties/hybrids with future traits	Improved legume varieties for intractable and future value-added traits grown by farmers for higher productivity and better markets in Africa and Asia
2022	Existing genetic engineering innovations such as aflatoxin resistance in groundnut and insect resistance in pigeonpea moved along the product development pipeline based on crop-specific stewardship and regulatory processes *at reduced scale			
2023	Elite genotypes of chickpea with improved seed and protein traits, pigeonpea with photoperiod insensitivity and groundnut with reduced aflatoxin contamination developed through gene editing and novel technologies. *at reduced scale			

Output 4. System analysis and phenomics to accelerate the development of crop products with enhanced environmental fitness, nutrition and marketability that raise the adoption of crop products by target smallholder farming communities and enhance their economic well-being and health				
Output 4.1. Crop simulation modelling designed to quantitatively characterize the target production environments (envirotyping/TPE definition) and effective GxM interventions for TPE targets deployed				
2021	Priority GxM and geographic targets defined with key stakeholders	ICRISAT, CGIAR, ARIs, NARS, universities and the private sector	Defined target production environments being used by crop breeding programs to develop most suitable varieties in target geographies	High-performing crop varieties delivering higher produce to smallholder farmers in target geographies of Africa and Asia
2022	Priority GxM and geographic targets defined with key stakeholders			
	TPE defined for critical crops-regions			
	Improved GxM system design for target TPE			
2023	Priority GxM and geographic targets defined with key stakeholders			
	TPE defined for critical crops-regions			
	Improved GxM system design for target TPE			
	Model for in-silico technology assessment tools established			
Output 4.2. Enhanced understanding of crop functions/mechanisms underlying their adaptation to abiotic environmental constraints (drought, heat, salinity) and their quality/nutritional densities/marketability (for humans and livestock)				
2021	Enhanced understanding of crop functions for crop fitness to environments prevailing in target TPE, and better crop produce quality/nutritional density/marketability	ICRISAT, CGIAR, ARIs, NARS, universities and the private sector	Physiological information on stress adaptation, nutritional quality being used in crop improvement programs to deliver abiotic stress-tolerant and more nutritious crop varieties	High-yielding, abiotic stress-tolerant and nutrient dense crop varieties delivering higher produce and better nutrition to smallholder farmers in Africa and Asia
	Priority setting done for crop-TPE and crop-quality			
2022	Enhanced understanding of crop functions for crop-fitness to environments prevailing in target TPE, and better crop produce quality/nutritional density/marketability. *at reduced scale			
	Priority setting done for crop-TPE and crop-quality			
2023	Enhanced understanding of crop functions for crop-fitness to environments prevailing in target TPE, and better crop produce quality/nutritional density/marketability *at reduced scale			
	Priority setting done for crop-TPE and crop-quality			
Output 4.3. Enabling technologies for rapid, robust, reliable and cost-effective phenotyping for crops' environmental adaptation and nutritional density				
2021	A range of phenotyping platforms, e.g. LeasyScan, LeasyField, unmanned aerial vehicle (UAV), near infrared spectroscopy (NIRS), computed tomography (CT) and X-ray fluorescence (XRF) established and operationalized	ICRISAT, CGIAR, ARIs, NARS, universities and the private sector	Trait phenotyping platforms being used by crop improvement programs to develop abiotic stress-tolerant and more nutritious crop varieties	Modernized crop improvement delivering high-yielding, abiotic stress-tolerant and more nutritious varieties to benefit smallholder farmers in Africa and Asia
	Standard operating procedures, tools, data processing pipelines and databases made available			
2022	Phenotyping platforms and services maintained and improved			
2023	Phenotyping platforms and services maintained and improved			

Output 5. Biotic stress resistance and management options that raise the productivity of mandate crops under subsistence smallholder farming systems established				
Output 5.1. Characterization of pests/plant pathogens and microbial imprinting undertaken and innovative tools for early detection and phenotyping, surveillance of emerging pests, diseases and parasitic weeds under climate change scenario established				
2021	Incidence of emerging pests and diseases in mandate crops assessed and key climatic factors responsible for emerging diseases identified	ICRISAT, CGIAR, ARIs, NARS, universities and the private sector	New tools and technologies for early detection and information on emerging pests and pathogens and new virulence of prevalent pathogens being used for the timely management of insect pests and diseases	Reduced pest-insect damage in farmers' fields from existing as well as climate change related biotic stress threats to grain legumes and dryland cereal crops in Africa and Asia
	Significantly important plant pathogens characterized for molecular and virulence diversity, and diverse pathotype-isolates selected for disease screening			
2022	New tools and technologies (sensors/Nucleic acid-based detection methods) developed for early detection of insect pests and pathogens			
	Effectors and host functions involved in plant x pathogen/insect-pest interaction identified *at reduced scale			
	Incidence of Maize Lethal Necrosis Disease (MLND) in sorghum in East Africa and losses due to fall armyworm (FAW) in sorghum and millet assessed			
	Major pests of chickpea and sorghum characterized for biochemical and molecular diversity *at reduced scale			
	Biological Nitrogen Fixation (BNF) potential of reference collections and elite breeding lines of chickpea, pigeonpea and groundnut assessed			
2023	*Artificial Intelligence (IA) tools developed for the identification of major pests and diseases and used for crop loss assessment across regions			
	Field diagnostics for aflatoxin detection developed			
	*Rhizoplane, rhizospheric and nodule-associated culturable bacteria of ICRISAT mandate crops mapped, characterized and evaluated			
Output 5.2. Diverse sources of resistance to target pests/diseases/parasitic weeds identified, information on mechanisms and inheritance of resistance generated, pest-free healthy germplasm conserved and shared globally				
2021	Breeding lines of mandate crops resistant/tolerant to diverse populations of insect pests and diseases identified	ICRISAT, CGIAR, ARIs, NARS, universities and the private sector	Durable resistance sources being used in crop improvement programs	Reduced pest-insect damage in farmers' fields from existing as well as climate change related biotic stress threats to grain legumes and dryland cereal crops in Africa and Asia
	Seed health status of more than 5000 accessions assessed annually to conserve healthy germplasm in the genebank			
2022	Source of resistance to FAW and other important insect pests identified and verified across regions			
	New sources of resistance identified from core/mini-core collections against diverse pathotypes of significantly important pathogens of mandate crops			
2023	Resistance sources identified against the parasitic weed *Striga*			
	*Mechanism of resistance to major insect pests and diseases investigated to identify diverse resistance sources for use in breeding programs			

	Stable and broad-based sources of resistance identified through multi-environment testing in disease nurseries at hotspot locations			
Output 5.3. Integrated pest/disease/parasitic weed management modules for dryland cereals and grain legumes developed for target cropping systems				
2021	Pre- and post-harvest interventions to mitigate aflatoxin contamination/storage pests established	ICRISAT, CGIAR, ARIs, NARS, universities, the private sector and farmer groups	Effective integrated pest management / integrated disease management practices being used by farming community in the target cropping systems	Reduced pest-insect damage in farmers' fields from existing as well as climate change related biotic stress threats to grain legumes and dryland cereal crops in Africa and Asia
	New natural enemies of FAW identified			
	New effective fungicides identified to salvage infected seed			
2022	*Effective parasitoids, entomopathogens, bio-pesticides, fungicides and new less toxic insecticides identified to manage major insect pests of mandate crop.			
2023	Combined management options to control FAW and Millet head miner validated			
	Safer end use alternatives of aflatoxin contaminated produce developed			
	Integrated disease management package developed for significantly important diseases of chickpea, pigeonpea, sorghum, pearl millet and groundnut			

Output 6. Delivering high-yielding, climate resilient, nutrient dense and market-preferred varieties and hybrids				
Output 6.1. High-yielding climate resilient (abiotic, biotic stress tolerant) varieties for market segments in the drylands				
2021	Product profiles, market segment refined and breeding pipelines aligned.	ICRISAT, CGIAR, ARIs, NARS, Universities and the private sector	1. Climate resilient improved varieties grown by farmers in Asia, ESA and WCA with adoption rate of 25-70% 2. Yield of pigeonpea, chickpea, groundnut, sorghum, pearl millet and finger millet increased by at least 10% 3. Yield stabilization on farmers' fields; crop production risk as a consequence of climate change reduced by 10-25%.	1. 30% increase in farmers' (women and men) income 2. 25% reduction in malnutrition and poverty 3. Food availability increased in target countries in Africa and Asia
	Elite breeding lines with target biotic and abiotic stress tolerance developed and shared with NARS and the private sector to conduct multi-location testing (MLTs) (annual)			
	Improved/optimized breeding schema enabling early multi-environment (ME) testing and recycling of parents, integration of available tools from other clusters			
2022	Heat-tolerant pearl millet and chickpea varieties and early-maturing pigeonpea developed and tested			
	Breeding material with multiple sources of resistance/tolerance stacked for biotic and abiotic stress			
	Genomic Selection approach established with Genomics, Pre-Breeding, Bioinformatics and Data Management and Analytical Support clusters (Annual) *at reduced scale			
	ME Testing Network developed for early generation testing of lines; data-driven product advancement as per stage and gate system (Annual).			

2023	RapidGen optimized and deployed for generation advancement of chickpea, groundnut and pigeonpea nurseries to rapidly generate fixed lines (Annual)			
	Drought-tolerant varieties with other market segment traits in chickpea, pigeonpea, groundnut, sorghum and finger millet developed and tested through integration of genomics and physiology information			
	Breeding lines with appropriate maturity duration to suit crop intensification and diversification in farming systems of the drylands developed			
Output 6.2. High-yielding climate resilient (abiotic, biotic stress tolerant) hybrids (sorghum, pearl millet and pigeonpea) for market segments in the drylands				
2021	Product profiles, market segment refined and breeding pipelines aligned	ICRISAT, CGIAR, ARIs, NARS, universities and the private sector	1. Climate resilient improved hybrids are grown by farmers in Asia, ESA and WCA with adoption rate of 25-70% 2. Yield of pigeonpea, sorghum and pearl millet increased by at least 10% 3. Yield stabilization on farmers' fields: crop production risk as a consequence of climate change reduced by 10-25%.	1. 10% increase in farmers' (women and men) income 2. 25% reduction in malnutrition and poverty 3. Food availability increased in target countries in Africa and Asia
	Inbred lines categorized for use in hybrid parent breeding programs on the basis of trait requirements separately for seed (female) and restorer (male) program and use of fertility/maintainer responses using genetic markers (Annual)			
	Conversion of seed parents initiated in genetic backgrounds suitable for different adaptation to develop A/B pairs for adaption to target production environment (Annual)			
	Testers identified for use in early generation testing to identify good combiner			
	ME Testing Network developed for early generation testing of inbreds for general combining ability (GCA); high GCA inbreds identified; data-driven product advancement as per stage and gate system (Annual).			
	Improved/optimized breeding schema enabling early ME testing and recycling of parents and integration of tools from other clusters			
	Partner with national and private sector organization to identify high-yielding hybrids specific combining ability (SCA) through METs, especially in Africa			
2022	RapidGen optimized and deployment initiated for generation advancement of pearl millet, sorghum and pigeonpea nurseries for rapidly generating hybrid parental lines (Annual)			
	Available hybrid parent breeding materials categorized into heterotic pools to be used for breeding and hybrid crosses; use of molecular diversity estimation tools (Annual).			
	Genomic Selection approach established with Genomics, Pre-Breeding, Bioinformatics and Data Management and Analytical Support clusters (Annual) *at reduced scale			
	Standardized hybrid seed production protocol intimated for pigeonpea and other crops in Africa			
	Further strengthening of the Hybrid Parents Research Consortium (HPRC) in Africa; available germplasm utilized in seed and restorer parent breeding programs by HPRC members.			

	Implementation of marker-assisted selection (MAS) approaches to pipelines for biotic and abiotic stresses			
2023	Good general combiners made routinely available in seed and restorer development breeding pipelines			
	Rf gene used regularly in hybrid parent breeding program			
	Speed breeding deployed to develop hybrid parental lines			
	Stable cytoplasmic male sterility (CMS) system identified across growing ecologies (specifically in pigeonpea)			
	Seed production protocols shared with partners for effective utilization			
Output 6.3. Deliver nutrition traits in breeding materials (elite lines, inbreds, varieties, hybrids) of grain legumes and dryland cereals				
2021-2023	Value of nutrition traits defined in ICRISAT crops and targets set with the help of the socioeconomics team	ICRISAT, CGIAR, ARIs, NARS, universities and the private sector	Farmers get extra premium for growing biofortified cultivars	Significant improvement in the dietary quality of poor people in the drylands who cannot afford high-end processed foods or animal-based protein products, thus improving human health and reducing the carbon footprint in Africa and Asia
	Highly adapted breeding lines/hybrid parents and segregating populations improved for nutritional traits and other product profile traits shared with public and private seed sector partners (Annual)			
Output 6.4. Deliver market-preferred speciality traits (herbicide-tolerant chickpea, high-malting sorghum and millets, multi-cut forage, feed, high shelling percentage, higher shelf life) in breeding material				
2021-23	Elite breeding lines/germplasm with herbicide tolerance identified for use as donor parents by chickpea breeding programs	ICRISAT, CGIAR, ARIs, NARS, Universities, the private sector, farmer groups and civil society	1. Improved access to farmers in Asia, ESA and WCA of the improved cereal and legumes cultivars 2. Increased income, nutrition and resilience 3. Improved access of NARS and the private sector in Asia, ESA and WCA to the improved cereal and legumes breeding lines	Cost of cultivation reduced by at least 15% and reduced drudgery for women Increased income for farmers through industry linkage Improved on-farm cultivar diversity Increased grain yield by 25%, pod yield by 25%, stover yield by 10% Increased resilience and adaptation to climate variability

				Increased livestock productivity Increased use of high digestible multi-cut forage Farmers receive high premium for varieties with high puffing quality
	Elite breeding lines with high malting quality developed by the sorghum and millets breeding programs.			Increased income for farmers through industry linkage
	Elite breeding lines with multi-cut forage developed by the sorghum and pearl millet breeding programs			Improved on-farm cultivar diversity
	Elite breeding lines with high shelling percentage developed by the groundnut breeding program *at reduced scale			Increased grain yield by 25%, pod yield by 25% and stover yield by 10%
	Elite breeding lines with high shelf life developed by the groundnut and pearl millet breeding programs *at reduced scale			Increased resilience and adaptation to climate variability
	Elite breeding lines with high blanchability and large seed size developed by the groundnut breeding program *at reduced scale			Increased livestock productivity-Increased use of high digestible multi-cut forage
	Chickpea breeding lines/germplasm with high puffing quality identified and used in the development of breeding populations			
	Dual purpose (food & fodder) varieties of groundnut, sorghum and pearl millet available *at reduced scale			Farmers receive high premium for varieties with high puffing quality

Output 7. Sustainable and timely access to quality seed of high-yielding market-informed varieties of drought-tolerant and nutritious crops at affordable prices				
Output 7.1. Market-informed gender-responsive product profiles developed				
2021	Market research data utilized to refine gender and nutrition-responsive product profiles and guide variety targeting	ICRISAT, CGIAR, NARS, universities and the private sector	Breeding pipelines guided by dynamic product profiles to meet specific needs of value chain actors in differentiated markets	Breeding programs deliver market-informed, gender-responsive varieties to smallholder farmers in Africa and Asia
2022	Product advancement criteria and process to prioritize varieties for commercialization established and standardized based on extensive TRICOT-based on-farm testing systems, demonstrations and exhibition			

2023	Participatory foresight data used to estimate the magnitude and geographical distribution of future demand for seed and grain			
	Existing product profiles refined using data from climate modelling and environment profiling of TPEs			
Output 7.2. Public and private sector actors engaged in extensive product testing, innovative demand creation and market-driven seed value chain development *at reduced scale				
2021	Robust performance, production, commercialization and marketing data availed	ICRISAT, CGIAR, NARS, universities, private sector, off-takers and farmers	Value chain stakeholders making informed data-driven choices on varieties to produce, sources of seed and associated production inputs and practices	Improved market-preferred varieties grown by smallholder farmers leading to greater yields and returns in Africa and Asia
2022	Additional robust performance, production, commercialization and marketing data availed			
2023	Continuous collection and analysis of robust performance, production and marketing data to inform commercialization decisions and feedback to crop improvement scientists			
	Innovative technology scaling models leveraged to create awareness and generate demand for good quality seed			
Output 7.3. Public and private sector actors engaged in innovative and effective seed production and delivery systems responsive to market demand				
2021	Innovative models of breeder and foundation and certified/QDS seed production documented	ICRISAT, CGIAR, NARS, universities, private sector, farmers, formal and informal seed value chain actors and grain value chain actors	1. Transformative models and policies for accessing, multiplying and disseminating public-bred varieties 2. Seed business enterprises (especially youth and women-led) profitably produce and market different classes of seeds 3 Faster varietal turnover reduces the age of ICRISAT mandate crop varieties in targeted countries	Improved market-preferred varieties grown by smallholder farmers leading to greater yields and returns and rural poverty reduction in Africa and Asia
	Technical and business capacity of public and private seed enterprises strengthened for profitable targeting of seed production and supply			
2022	Women and youth-friendly seed business models developed			
	Digital tools for seed systems developed and promoted			
2023	Selected models of breeder, foundation and certified seed production tested through demand-led public and private partnerships			
	Policy solutions to facilitate varietal handover for commercialization initiated *at reduced scale			

*Output targets adjustments with 30% budget reduction

Global Research Program: Towards inclusive and resilient farm and food systems for nutrition in the drylands

Program Overview and Rationale

Agriculture, including crop and livestock production systems, are the largest global users of land and water resources and provide employment to over 1 billion people, about 30-40% of the labor force. With food demand driven by rising incomes in Asia and rapid population growth in Africa, food deficits are predicted to expand (cgspace.cgiar.org). Such deficits, which are being met increasingly by imports, can also be filled through sustainable intensification. In the drylands of SA and Africa, rapid demographic changes are taking place together with the lack of resilient livelihood options in rural areas. These challenges require a paradigm shift in the way agricultural landscapes can be designed (cgspace.cgiar.org) and managed to support sustainable and more equitable smallholder livelihood systems.

There is potential to achieve sustainable intensification in agricultural landscapes in developing countries with recent research showing that targeted investments in agricultural land and water management and associated policy interventions can double or triple crop yields. While simply closing yield gaps on farms which are often too small to even meet the food security needs, let alone the economic needs of smallholder farming families, using landscape and community farming allows broader opportunities for creating livelihood systems to also be considered. Such an approach then takes the focus beyond the farm level to develop innovative and collective approaches to managing landscapes for restoration, aggregating primary products for more effective marketing, employing digital means to exchange information and creating opportunities for agri-entrepreneurs, to mention a few.

The focus of this Global Research Program is therefore on rainfed crop and crop-livestock-agroforestry systems and smallholder irrigated systems.

Output Targets

At the farm scale to close yield gaps:

- The implementation of agricultural land and water management strategies and livelihood options – sustainable intensification strategies coupled with multi-stakeholder innovation platform processes that link productivity improvement to wider impacts
- Testing and scaling of improved and resilient farming systems (including integration and intensification of crops and livestock-agroforestry systems) and rotations that support diversification, risk management, income generation, resource conservation and sustainability
- The use of climate information services coupled with ICT to enable delivery systems to scale decision support information and de-risk farm management
- Mechanization and digital innovations to reduce drudgery, such as introducing mechanization in primary operations (land preparation, sowing, weeding, fertilizer application and harvesting) and processing (threshing, chopping and dehulling)
- Prediction of extreme weather events or pest and disease outbreaks linked to early warning systems and response advisories.

At the watershed scale to build collective action:

- Scaling of agricultural landscape water management (ALWM) strategies that enable overall improvements in natural resources (e.g. hydrology, cover, erosion, etc.) and collective management (commons, catchments, groundwater extraction)
- Science that supports the scaling of integrated watershed approaches that reaches policymakers, investors, donors and change agents
- Application of geospatial information in targeting interventions (prioritizing watersheds, designing and locating land engineering structures, site-specific nutrient management)
- Development of scaling-up models for large-scale diffusion of proven agriculture smart technologies.

At the community scale:

- Support social processes to collectively manage resources and create new innovations for marketing (especially digital solutions to aggregation and collective marketing)
- Digital innovations that support community processes and knowledge exchange
- Development of community-based watershed and farm decision support tools for improved soil, nutrient and water use efficiency and soil carbon sequestration.

Alignment with SDGs: 1 (No Poverty), 2 (Zero Hunger), and 13 (Climate Action) while contributing to 5.b (Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women) and 17.6 (Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation).

Outcomes

- New and upscaled technologies, sustainable natural resource management approaches and business models available to help rural communities enhance incomes and livelihoods and ensure sustainable resource use at the landscape level to build resilient farm and food systems in the drylands of Asia and Africa
- Climate-smart innovations, approaches and scaling mechanisms including early warning systems are evidenced for their effectiveness (ecosystem services, economic benefits, etc.) in mitigating risks of climate variability and change
- Increased rate of adoption and replicability of best management practices in landscape restoration
- Enhanced efficiency of change management to transform farms and landscapes, rural women and youth engagement in local entrepreneurship, changed behavior of farmers and consumers, increased income, nutrition and resilience and reduced rural poverty.

Impacts

- Sustainable natural resource management from farm to landscape scale coupled with the adoption of context specific technologies and farming system diversification contribute to sustainable intensification, enhanced system resilience and food security and reduced land degradation in the drylands
- Increased adaptation to climate variability and change - reduced greenhouse gas emission
- Improved groundwater availability, enhanced cropping intensity and resource use efficiency and transformation of fragile landscapes into resilient production systems
- Improved nutrition of rural and urban populations through greater consumption of diversified food
- Farmers and traders benefit from greater competitiveness in markets, and rural youth and women find livelihoods as small- and medium-scale entrepreneurs.

Logical Framework of Global Research Program: Resilient farm and food systems: Major outputs, intended users, outcomes and impacts

Outputs	Output targets	Intended users	Outcomes	Impacts
Global Program: Towards inclusive and resilient farm and food systems for nutrition in the drylands				
	Towards inclusive and resilient farm and food systems for nutrition in the drylands Reduce rural poverty and enhance system resilience through the introduction of new technologies for natural resource management and creation of livelihood opportunities	State and national governments, NGOs, donor community, NARES, ARIs, farmer organizations, and the private sector	New and upscaled technologies and business models help rural communities enhance income and livelihoods, and mitigate climate risks.	Farmer annual income, system resilience and food production increased through the adoption of technologies and crop diversification leading to sustainable intensification of dryland systems. Improved nutrition of rural and urban populations through greater consumption of diversified food. Farmers and traders benefit from greater competitiveness in markets, and rural youth and women find livelihoods as small- and medium-scale entrepreneurs.

Output 1:	Climate adaptation and mitigation			
2021	Climatic change risk profiles mapped and developed for different regions, and existing technologies and practices for adaptation and mitigation participatory identified/prioritised at the landscape level Phenomics for climate resilience	NARES, researchers, students, farmers and development agencies	Climate risk profiles and context-specific climate-smart agriculture options are available for further investigation	Increased productivity and income; increased adaptation to climate variability and change; reduced greenhouse gas emission, differentiated for men, women and youth
2022	Potential climate-smart innovations, approaches and scaling mechanisms tested with communities/farmers to evidence their climate-smartness New technologies and innovations on climate adaptation *Geographies restricted to core countries/sites	NARES, researchers, students, farmers and development agencies	Climate-smart innovations, approaches and scaling mechanisms are evidenced for their effectiveness (ecosystem services, economic benefits, etc.)	
2023	Innovative partnerships developed for behaviour change and large-scale adoption of proven climate-smart options Increased climate resilience *Geographies restricted to core countries/sites	Development agencies, rural sector line ministries, private sector actors, donors	Innovative partnerships involving public and private sectors are developed to bring to scale science-evidenced CSA options Enhanced climate resilience	
Output 2:	Landscape resource management technology identification, validation and piloting			
2021	Agro-ecology specific landscape restoration technologies identified and piloted Region-specific crop-livestock-agroforestry intensification developed	NARES, development agencies, researchers and farmers	Water balance components along with rainwater harvesting threshold is available for different regions Robust rainwater harvesting structure designs	Improved groundwater availability, enhanced cropping intensity and resource use efficiency Enhanced land and water-use efficiency
2022	State-of-the art monitoring system established in select benchmark sites (*limit to funded locations) to analyze the impact of landscape restoration initiatives on various ecosystem services at different scales	Researchers, donors and students		

2023	Region-specific rainwater harvesting threshold defined and strategies developed for resource optimization *Geographies restricted to core countries/sites and reduced ground truthing/partner engagement	Development agencies, Researchers	Balanced ecosystem trade-offs between downstream and upstream	
Output 3:	**Integration and scaling up of landscape restoration and field-based technologies for building system resilience**			
2021	Sites of learning/benchmark sites to demonstrate science- backed innovations in dryland systems established	NARES, development agencies, donors, researchers, students and farmers	Evidence-based learning sites are available to demonstrate the potential of dryland systems New and upscaled technologies for water, nutrient, soil management and climate resilience	Transformation of fragile landscapes into a resilient production system
2022	Landscape and field-based interventions for a resilient and profitable production system integrated Efficiency of change management to transform farm and landscape enhanced *Efficiency of change management to transform farm and landscape enhanced	Farmers and rural communities		
2023	Development agencies and policymakers influenced through science-based evidence of landscape restoration (e.g., Haveli cultivation) *Geographies restricted to core countries/sites and reduced ground truthing/partner engagement	Development agencies, policy-makers and donors		
Output 4:	**Knowledge dissemination through capacity and awareness building initiatives for scaling up best management practices**			
2021	Capacity building modules specific to natural resource management developed	Development agencies, farmers and grassroots level workers	Increased rate of adoption and replicability of best management practices of landscape restoration Business model to help enhance income	Improved profitability, sustainability and strengthened ecosystem services Reduced rural poverty Enhanced system resilience
2022	Created awareness among a range of stakeholders on	Development agencies, farmers,		

	landscape restoration strategies and their benefits *Geographies restricted to core countries/sites	researchers and policymakers	Increased income, nutrition and resilience	
2023	Capacity and awareness building programs for different stakeholders organized and new knowledge disseminated *Rural and youth engagement in local entrepreneurships	Development agencies, farmers and researchers		
Output 5:	Geospatial and big data science			
2021	Prioritizing watersheds using biophysical parameters; Geospatial information to support insurance products Yield assessment using technology	Policymakers, researchers, donors, insurance and re-insurance companies	Identification of watersheds for productivity enhancement and soil and water conservation Yield estimation. Insurance.	Sustainable land and water management; crop diversification and enhanced crop productivity
2022	Impact of NRM interventions on land use land cover (LULC) changes *Geographies restricted to core countries/sites and reduced ground truthing/partner engagement	Policymakers, researchers and donors	Identification of LULC changes, input for hydrological and social scientists	
2023	Acreage of major cereals and legumes, crop water productivity estimated *Geographies restricted to core countries/sites and reduced ground truthing/partner engagement	Policymakers, researchers, donors and agriculture extension officers	Crop area estimations and inputs for yield predictions	
Output 6:	Digital agriculture			
2021	Suite of digital innovations ranging from weather-based advisories through to digital tools/platforms supporting market linkages, knowledge dissemination and early warning systems identified and piloted in target regions	NARES, development agencies, donors, researchers, students and farmers	Digital innovation design is based on a sound needs assessment and data is collected for a more scientific evaluation of the pros and cons of various digital innovations	Digital tools and technologies are increasingly exploited by NARES, governments, industry and other value chain actors to improve the overall performance and efficiency of the agri-food system. Digital tools are available to cater to decision making for actors at various spatial (farm, community, landscape, etc) and temporal scales.
2022	Data from pilots compiled and synthesized to evaluate the intermediate outcome of the digital innovations and also to identify key enablers for maximum impact of digital innovations	Farmers and rural communities	Empirical evidence around the use of digital innovations in agriculture available and can inform investments in this space	

	*Geographies restricted to core countries/sites			
2023	Work with national and state governments, industry, academia and other ecosystem players to upscale and mainstream proven digital innovations *Geographies restricted to core countries/sites	Development agencies, policymakers and donors	Policymakers, donors and other investors base their investment decisions on data and are therefore likely to get more returns for every dollar invested Strengthened capacity Changed behaviour of farmers and consumers	

*Output targets adjustments with 30% budget reduction

Global Research Program: Enabling transformations through improving policies, facilitating institutional innovations, markets, and scaling impacts and capacity development to support sustained reduction in poverty and malnutrition in the drylands

Program Overview and Rationale

Smallholder farmers face major challenges like poor quality of life, food insecurity, fragmented land holdings, rise in input costs and poor access to markets and institutions. These are further aggravated by climatic and other shocks like COVID-19 faced together with the lack of technical support, access to input and output markets, and scant value addition opportunities. A robust, systemic and transformative approach towards improving the livelihood of farmers is needed, helping them move from low input-low output subsistence farming to produce profitable surpluses by sustainably harnessing production potential and ensuring access to markets.

Any approach to transform agriculture must focus on improving food and nutritional security and reducing poverty, which is key to human growth and mental development (Ravula et al. 2017). A dearth of both micro and macronutrients, coupled with inaccessibility to proper sanitation and hygiene compromises the health of vulnerable groups such as adolescents, infants, pre-school children, women of reproductive age and the elderly (IUNS, 2017). Inadequate purchasing power caused by the lack of additional income opportunities exacerbates malnutrition. Thus, the key to breaking out of this vicious cycle of food poverty and its adverse effect on the quality of human life lies in linking agriculture, nutrition and markets, with equitable access and benefit sharing for all. Promoting the smart food initiative is one of the several approaches to take to diversify staples – not with any food – but that which fit into the smart food criteria of being good for individual, good for the planet and good for the farmer.

Post-harvest value addition and output markets for nutrition security are key strategies across the African and Asian drylands. Post-harvest value addition and markets for nutritious foods decrease the unit cost of nutrients and increase the economic and nutritional values of processed products and make them readily available to the end user, which may ultimately benefit the farming community at large through market linkages. Markets are also key to creating a “demand pull”, thereby reducing the cost of production and promoting sustainable market-driven practices.

A value chain approach involving all key stakeholders can offer sustainable financial benefits to smallholder farmers in Africa and Asia. Maximizing their produce through cost-effective and innovative post-harvest interventions, however, will be necessary to promote food and nutritional security. Furthermore, exploiting the nutritional potential of the crops to develop value-added products and ultimately providing the conditions to foster entrepreneurship at the community level based on the development of innovative products and technologies is key towards achieving nutritional security.

Collective farming, value chain integration and access to primary processing facilities can be viewed as an effective, transformative approach to solve problems faced by smallholder and marginal farmers, especially women and youth. Collective action by farmers and organized farmer groups have been known to be effective mechanisms to reduce the cost of production, enable access to quality input and technology and facilitate better market linkages. Small-scale and marginalized farmers can join together and integrate into the value chain by providing marker-driven value addition opportunities. Decentralized processing units at the farm level help reduce post-harvest losses and provide employment to rural youth, besides improving farmers' economic and social status. Marketing of the processed products provides an additional entrepreneurial opportunity to harness the potential of rural youth. Creating conditions for value addition and opportunities of entrepreneurship help farmer groups to view themselves as a business entity rather than simply being a cooperative.

Finally, institutions are part of the structural framework under which agricultural production, post-harvest value addition and (collective) marketing are carried out. Some elements of this framework encourage innovation, such as conservation agriculture, others hinder it. Without coordinated and coherent agricultural strategies, equitable market regulations and trade policies, it is difficult for farmers and the private sector to sustainably operate market-oriented production methods and investments. This is particularly true of ICRISAT's mandate crops. Hence, every production- or market-oriented innovation is doomed to fail if the political framework, food policies and market institutions do not work for the fair benefit of all.

In this context, the analysis of policies that are explicitly geared towards promoting the big three (rice, maize, wheat) and, thus indirectly reducing the marketability of other crops appears particularly important. These include studies on price support, import and export facilitation, trade restrictions, government policies and phytosanitary measures that are selectively applied to individual crops. Political economy analyses appear just as central to building a strong narrative around ICRISAT's mandate crops to increase their presence on both the fields and plates. Policies also include those developed and approved by local governments. An overarching task of policy coordination is to harmonize these public and private policies with the overall strategy of the agricultural sector in the respective country or region.

Alignment with SDGs: 1 (No Poverty), 2 (Zero Hunger), and 13 (Climate Action) while contributing to 5.b (Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women) and 17.6 (Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation).

This program aims to provide empirical evidence and information for developing sustainable markets, policies and regulations to create enabling conditions for the transformation from subsistence-oriented to market-oriented sustainable dryland agriculture. A demonstrative model on strengthened value chain for all stakeholders, especially farmers aggregated to form producer groups and their participation in value chain through value addition, can show them the real benefits in quantitative terms. The program also focuses on relevant policies that support the scaling of sustainable land management and water-efficient farm management practices and landscapes. It additionally examines policies that promote the production and consumption of ICRISAT's mandate crops contributing to affordable and sustainable diets and livelihoods. This program helps generate steps towards political and institutional reforms by analyzing existing policies and experimenting with incentive systems.

Output Targets

- Improved targeting and prioritization of plot, farm and food system interventions offered (e.g., recommendations for the reform of policies and strategies to increase the proportion of mandate crops in private and public food aid, mitigating food system fragilities through social protection and public procurement, etc.)
- Enhanced efficacy of change management tools for transforming farm and landscapes developed (e.g., experimental investigations into monetary, cultural, social stimuli and incentive systems for adopting technologies and consumer behavior change)
- Strengthened markets and market linkages developed for drylands crops (analysis of agricultural and trade policies and market institutions that promote or hinder the scaling of mandate crops, specifically drought-resilient crops, sustainable dryland farming technologies, etc.)
- Demonstrated value chain model benefitting farmers through participation in the value chain (e.g., increased income of farmers through aggregation in groups, community level models created on entrepreneurship and linkages to community nutrition)

- Strategies for accelerated and coordinated policy reforms, enabling environment developed, tested and implemented (e.g., impact of policy changes on youth employment, and evidence for policymakers to understand the return on investment, which improves targeting and public and private investments)
- Engaging rural women and youth in local entrepreneurial opportunities in agricultural and allied sectors.
- Introducing new processed food products of millets and legumes to enhance the nutritional status of rural populations, developing and promoting smart food for farmers and consumers together with the public and private sector stakeholders
- Enhanced climate resilience
- Increased access to quality seed and high-yielding, nutrient-dense and market-preferred varieties
- Enhanced system resilience.

Outcomes

We expect a significant change in behavior from farmers and consumers by implementing reforms in policies and current market institutions. Some will have direct effects on income, resilience and nutrition. Farmers' engagement in business operations emerges and demonstrates models that are scalable and replicable. Other reforms are intended to strengthen capacity, motivate and fortify the processing industry (both SMEs and large scale) and other key players in the value chain to switch to the mandate crops. Overall, we expect better functioning value chains for ICRISAT's mandate crops resulting from policy reforms. We anticipate that the demand for crops improved by ICRISAT researchers will increase through more impactful incentive systems. Consequently, the coverage of these crops will also increase in Africa and Asia. The program will contribute to better varietal development decisions in future, development of market-preferred varieties, strengthened formal and informal seed systems and bolstered capacity of different stakeholders. Program developed decision support tools and approaches are expected to promote climate smart agricultural policies and investments and smart food. This program shall also assess the potential demand of ICRISAT mandate crops in non-traditional areas (beyond drylands) and can provide what would be the conditions for increasing the demand in non-traditional areas and also identify the emerging new areas beyond for production of ICRISAT crops beyond drylands.

Impacts

We expect a significant increase in environmental health through policy-induced changes in human behavior regarding mandate crops, particularly by scaling legumes as intercrops and crop rotations, contributing to enhanced systems resilience. Better access to market will increase farmers income and reduce poverty. Better reach to market will also improve nutritional security. Increased production of legumes will improve eco-system services. Economic development is anticipated through the strengthening of value chains and the development of micro-enterprises in rural areas. As a result of dietary changes, an improvement in human health, particularly of poor farmers and consumers, including men, women and youth living in precarious conditions is expected for different stakeholders. Climate smart investments and incentives are expected to enhance the resilience of value chains and food systems in drylands regions.

Logical Framework of Global Research Program: Enabling Systems Transformation: Major outputs, intended users, outcomes and impacts

Outputs	Output targets	Intended users	Outcomes	Impacts
Global Research Program: Enabling transformations through improving policies, facilitating institutional innovations, markets, and scaling impacts and capacity development to support sustained reduction in poverty and malnutrition in the drylands				
Output 1: Improved targeting and prioritisation of plot, farm and food system interventions offered				
2021	DNA fingerprinting for adoption tracing and IA applied to critical mandate crops in Africa and Asia	ICRISAT scientists, Ministries of agriculture and the donor community	Improved targeting and prioritisation of interventions supporting the transformation of	Return on investment of donor community increases substantially
22022	Customer and product profile procedure developed for ICRISAT mandate crops High-yielding climate resilient varieties			

2023	System analysis protocol established for better targeting of ICRISAT technologies across the drylands Two rigorous impact assessment studies conducted to support ICRISAT's strategic communication for visibility and partnership *Geographies restricted to core countries/sites and reduced ground truthing/partner engagement		farming food systems Better varietal development decisions Market-preferred varieties for Asia, ESA and WCA	
Output 2: Enhanced efficacy of change management tools for transforming farm and landscapes developed				
2021	Scalable games for behaviour change in farm and landscape management developed	ICRISAT Development Center (IDC), NGOs, the private sector and farmer organizations	Enhanced utilisation of change management approaches fit for complex, fragile systems	Coordinated and collective action transforms drylands farm and landscapes
2022	Multipurpose/multi-level innovation platforms standardised and institutionalised			
2023	Change management procedures and protocols for scaling, a community of practice institutionalised *Geographies restricted to core countries/sites and reduced ground truthing/partner engagement			
Output 3: Strengthened markets and market linkages developed for dryland crops				
2021	Social business models developed and implemented	Agribusiness and Innovation Platform (AIP), national public policymakers, private sector partners and social entrepreneurs	Reduced transactions costs and value chains Improved bargaining power of smallholders Market players benefit from re-configured market dynamics and strategies	Higher price realization Enhanced benefit-sharing by smallholders Increased income, prosperity and well-being
2022	Dynamic value chain models developed to support market development and to create "demand pull" for ICRISAT mandate crops *Geographies restricted to core countries/sites and reduced ground truthing/partner engagement			
2023	Improved markets and agri-business opportunities provided around ICRISAT mandate crops to deliver nutrition in drylands regions			
Output 4: Strategies for accelerated policy reforms, enabling environment developed, tested and implemented				
2021	Policy evidence to enhance uptake of regenerating and resilient technologies	Public policymakers, private sector/impact investment NGOs and development agencies	Policymakers use evidence to improve enabling environment Strengthened formal and in-formal seed systems	Improved nutritional and monetary well-being of farmers, processors and consumers
2022	Improved natural resource management institutions and policies presented as models			
2023	Improved guidance for inclusive and equitable food policy and impact finance/investment developed Increased access to quality seed Enhanced system resilience			
Output 5: Engaging rural women and youth in local entrepreneurial opportunities in agricultural and allied sectors				
2021	Identification of business opportunities in rural areas and development of sustainable business models	FPOs and regional business incubators	Emergence of local business entities	Self-employment of women and youth and regional economic development

	Promoting smart food for better nutrition and health	Farmers, consumers and provincial government	smart food becomes an integral part of food systems	Better nutrition, improved health of farmers and consumers
2022	Engaging women and youth in business opportunities through a competitive process *Geographies restricted to core countries/sites and reduced ground truthing/partner engagement	Financial institutions	High rate of business success with potential entrepreneurs	
2023	Handholding and mentoring of women and youth	Provincial government and social venture capitalists	Assured sustainable business operations Strengthened capacity	
2026			SME agribusiness scaling up to mid-size enterprises	Market connect to farmers with better price realization
2031			Reverse migration of youth to villages	Regional economic contribution to national GDP
Output 6: Introduction of new processed food products from millets & legumes for enhancing the nutritional status of rural population				
2021	Establishment of primary and secondary processing units for millets and legumes	National government and international foundations	Access to infrastructure for value addition to local crops and higher income for farmers	Successful linkage of agriculture and nutrition with impact on rural community
2022	Developing the commercial viability of processing units *Geographies restricted to core countries/sites and reduced ground truthing/partner engagement	Regional business incubators	Growth in local food processing industry and markets	
2023	Nutritional intervention for rural women and children *Geographies restricted to core countries/sites and reduced ground truthing/partner engagement	Nutrition missions, school and community feeding programs, developmental organizations and World Food Program	Better health status of rural population	
2026			Rural population aware of the benefits of millet and sorghum	Popularization of millet and sorghum-based products and industries
2031			Millet- and sorghum-based staple food products part of dietary routine	Malnutrition overcome in rural areas

Integration between the Global Research Programs

The activities in the three Global Research Programs shall be implemented in three ICRISAT targeted regions of Asia, ESA and WCA through a number of initiatives/projects that the institute will implement between 2021 and 2023 with the help of partnerships with different stakeholders, including South -South collaboration for inter-regional transfer of technologies. ICRISAT's innovation philosophy considers development challenges such as human malnutrition, environmental degradation, resource conflicts in addition to urbanisation and associated market opportunities as starting points for product development. This process involves users of ICRISAT's mandate crops and technologies early in the design process. Each of the Global Research Programs addresses a critical research domain relevant to the progress of cereals and legumes fit for dryland regions. Therefore, our stage-gate strategy for crop improvement starts with a comprehensive system analysis to explore market intelligence, conduct gender analyses and foresight assessments to develop costumer and market profiles for potential products. These profiles inform pre-breeding and crop improvement strategies. As such we ensure product development for specific market segments and increase the likelihood for uptake. As we work towards releasing new varieties, researchers help in developing complementary agronomic measures to realise the full genetic potential of crops on plots and farms. Finally, researcher accompanies the piloting and scaling of both crop varieties and farm technologies. The Accelerated Crop Improvement program develops new varieties which are market-driven. The Resilient Farm and Food Systems program develops agronomic practices, conserving soil and water resources, and minimizing climate risk. The Enabling System Transformation program explore enabling socio-economic and policy environment for up-scaling of new varieties and management practices in drylands and beyond. Based on a clear division of labour within ICRISAT, each stage during crop and product development will involve experts in the field. Unlike traditional stage-gate models that are criticised for being overly linear, we will organise our product development along dynamic experimentation and learning in cooperation with users.

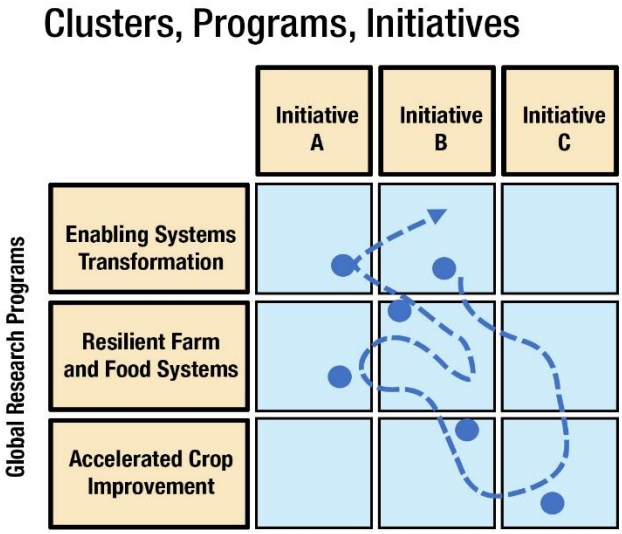


Figure 2: Integration between different Global Research Programs for different initiatives.

Our research is solution oriented. We focus on current and future challenges of agriculture in African and Asian drylands. Each of the three research programs has a comparative advantage in developing marketable crops for dryland food systems (future 2). Program 1 (Accelerated Crop Improvement) genetically improves crops to unlock their multifunctional effect in complex, fragile regions. The task of Program 2 (Resilient Farm and Food Systems) is to combine the different ecological components of farm systems to promote and increase the resilience of rural systems. Only through this interplay of plant sciences, agronomy, and technology development it is possible to increase the resilience of rural systems. Farming systems are inevitably linked to the surrounding system elements including input and output markets, food policies and consumption preferences within the society. Only through the collaborative development of these up-and downstream components are changes in food systems durable and sustainable. The objective of program 3 (Enabling System Transformation) is, therefore, to develop processes using their conversion of the entire food systems.

Our research and development are based on the following partnership principles to strengthen cooperation between the three research programs.

- Our research is anchored in a scientific discipline. The basis for the disciplinary home of staff in research programs is the training of the scientists.
- Scientists at ICRISAT work on developing joint research objectives and support the exchange of these objectives through regular communication and consultation and the exchange of data.
- The identification and characterization of research problems is a collaborative effort across disciplines and research programs. At project level, each research team consists of the relevant disciplines that are relevant for processing a research question.
- We endeavour to expand our competencies in multidisciplinary research continuously. Therefore, particular emphasis on capacities development, training and an incentive system supports this cooperation between disciplines.

To ensure that the global research programs do not work in silos in future, crop teams for each crop for specialization needed across research programs will be developed and connected. Such crop teams will include crop breeders, agronomists, water management scientists, soil scientists, post- harvest experts and agri business development experts to enable them work and take forward holistic approach for each crop starting from breeding to value chain development and dissemination.

4. Impact Pathways

Transition towards sustainable dryland agriculture in Africa and Asia is constrained by the complex interplay of agricultural technologies, market (dis)incentives, institutions and policies as well as agro-ecological degradation and climate crisis. The challenges of food and nutrition insecurity, poverty, gender inequality, climate change and environmental degradation in the drylands are interconnected. We believe that catalyzing a healthy balance of technical, socioeconomic and institutional innovations transforming farming and food systems in the drylands can help realize improved nutrition, health and food security; poverty reduction and more jobs; equity and social inclusion; climate adaptation and mitigation and environmental health. However, current innovation capacities amongst actors as well as institutions and policies in the dryland regions of Asia and Africa are the key limiting factors for driving such impactful innovations. These three innovation dimensions are the basis of our impact pathways, embedded in our larger Theory of Change (ToC). ICRISAT's three Global Research Programs will converge to generate products, services and innovations through accelerated crop improvement, resilience building approaches, practices and tools, and innovations supporting an enabling environment through innovation systems of partnerships, networks, assets and institutions to deliver improved access to healthy diets and income opportunities within environmental limits.

First, we develop and test scalable agricultural technologies and improve the genetic material of six key dryland cereals and legume crops. This is the core of the Global Research Program on Accelerated Crop Improvement. Sustaining and utilizing the biodiversity of ICRISAT's mandate crops for current and future generations, we co-create and co-develop resilient, higher yielding and nutritious cultivars based on the NARES shared agendas, product profiles, varietal development, large-scale trials and release processes and link to seed systems. Advanced genomics and molecular biology tools support faster development and integration of high potential traits into crop improvement. The accelerated production of highly nutritious legumes and cereals in the drylands through enhancing the genetic gains is complemented by the Global Research Programs on Resilient Farm and Food Systems and Enabling Systems Transformation by increasing the availability of technologies adapted to climate risks and responding to new market opportunities. We leverage disruptive technologies on big data and digital agriculture in partnership with the fast emerging agri-tech start-up ecosystem that enables cost effective and inclusive scaling of technologies at a swift pace to achieve large impacts. Through participatory large-scale piloting of technologies of dryland cereals and legumes from plot to landscape and household to markets as integrated solutions in partnership with relevant actors would improve farming and food systems around ICRISAT mandate crops in drylands. Markets, consumer product profiles and evidence on enabling policies and institutions and market arrangements supported through the Global Research Program on Enabling Systems Transformation will enable increased adoption of context specific varieties and natural resource management technologies for nutrition and resilience.

Second, our socioeconomic impact pathway helps influence consumer behavior, reshape markets and value chains and facilitate agri-business innovations to enable the supply of healthy food from producers to consumers and create more jobs along the value chains.

Thirdly, our institutional impact pathway supports the creation of policy frameworks and incentives that are needed to promote technology adoption, ecological intensification, market orientation and nutrition-sensitive value chain development. These second and third impact pathways are anchored in the Global Research Program on Enabling Systems Transformation through improving policies, facilitating institutional innovations, markets and scaling impacts and capacity development to support sustained reduction in poverty and malnutrition in the drylands. In collaboration with regional and global stakeholders, the co-creation of innovations and strengthening the capacity of national and sub-national partners to transform farming and food systems around dryland cereals and legumes would be central to our impact pathways. The three Global Programs will anchor and harness South-South partnerships to contribute to agri-food system transformation to achieve the SDGs in the drylands of Africa and Asia.

Achieving impact is never guaranteed but are made possible when working with strategic partners right from formulating the research program. By default, impact pathways we develop jointly with users (figure 3). When developing crops, technologies or services for a specific market, stage-gating principles guide our work and the organization of research teams. The further our research is geared towards implementation and scaling, the bigger is the role of our partners. These partners include NGOs, the private sector and government agencies, especially the agricultural research and extension systems in our partner countries. Only through such partnerships we can translate institutional outputs into system-level outcomes and impact. In our work, we consider capacity development to enhance the ability of farm and food systems to innovate of special importance.

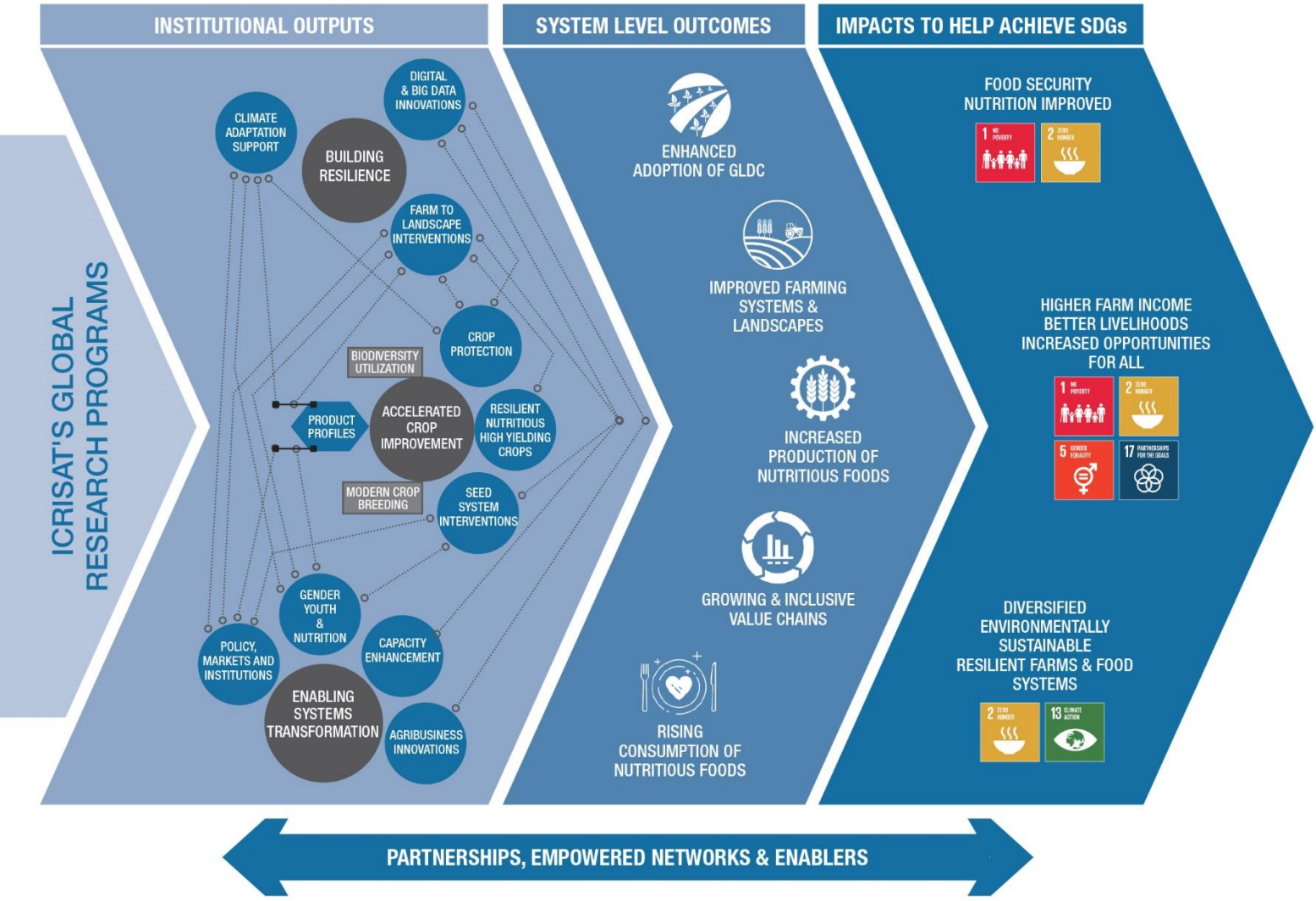


Figure 3: Impact Pathway for MTP 2021-23

5. Alignment with UN Sustainable Development Goals (SDGs)

ICRISAT's work will contribute directly to the achievement of the UN Sustainable Development Goals: SDG 1 No Poverty, SDG 2 Zero Hunger, SDG 13 Climate Action while also contributing to SDG 5.b Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women and SDG 17.6 Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation.

ICRISAT is uniquely positioned to develop solutions that significantly contribute to the achievement of the SDGs by increasing food production and nutrition security in the drylands region which is most vulnerable to climate change and environmental degradation and home to 600 million smallholders and more than 2.1 billion resource poor people. ICRISAT works with nutritious and climate ready crops millets and legumes that have high potential to contribute to sustainable nutritious food production under a climate change scenario and also augment the livestock component of dryland farming systems, strongly contributing to SDG 1 and SDG 2. Women in the drylands face increasing job insecurity, taking on the drudgery of agricultural work done by men for relatively lower earnings. ICRISAT shall work with different stakeholders to develop gender responsive technologies, policies, linkages, and opportunities suitable for small farms in order to reduce drudgery in agriculture and facilitate gender equality to contribute to SDG 5.b Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women.

Climate risk management is arguably one of the greatest challenges for agricultural production in the drylands of Africa and Asia where crop seasons are short, and rainfall is highly variable. ICRISAT shall work to develop climate adapted crop varieties and technologies and ensure that climate adaptation and mitigation measures are implemented at landscape level to reduce risks and losses in a timely action as management strategies to meet SDG 13 on Climate Action.

The three Global Research Programs shall be implemented at all levels foundation, translational, adaptive as well as scaling up for impact in partnership mode with a large number of stakeholders. ICRISAT will continue to follow the CGIAR vision of making freely available public goods through partnership at global, regional and local levels with different stakeholders in order to enhance progress towards climate resilience and nutrition, reduced poverty and hunger and mainstreaming gender and environment sustainability in the drylands.

6. Outputs, Development Outcomes and Aspirational Targets

The research conducted during the MTP 2021-23 will generate 15 global outputs in the form of new knowledge and technologies, methods, tools, policies, and capacity development. ICRISAT's three Global Research Programs will work jointly in regions with different governments and partner institutions from the public and private sectors to produce these outputs. Progress towards these outputs will be monitored through the annual achievement of the research activities undertaken. The 15 outputs will be translated into 11 development outcomes working together with hundreds of partners including agri- tech start-ups, farmer collectives, civil society organizations and communities in the regions to meet the 7 aspirational targets-no poverty, no hunger, improved Nutrition, reduced environmental degradation, enhanced climate resilience, empowered women-youth and global partnerships (Figure 4). ICRISAT recognizes that the drylands are highly variable environments housing people with very diverse needs. ICRISAT will capitalize on investment opportunities for the public sector, the private large-scale commercial sector, the community sector and the household or small-scale private sector to meet these diverse needs in different regions. As an international research organization, ICRISAT will focus on developing and delivering quantifiable outputs such as new varieties, crop management technologies, climate resilience strategies, inclusive and nutrition-sensitive value chains, digital innovations, gender transformation strategies and capacity strengthening services. These shall be achieved through combinations of foundation, translational and local adaptive research concurrently with scaling for impacts, working together with a large number of partners in different regions. Changes in the drylands brought about through our efforts can be assessed by measuring improvements in the living conditions of the affected population in terms of food-nutritional security and enhanced income and resilience. The MTP 2021-23 provides an opportunity to increase the productivity of ICRISAT's mandate crops and the incomes of smallholder farmers in traditional dryland areas. In non-traditional areas, it will involve introducing our mandate crops both for production and consumption while exploring opportunities to place these crops on an equal footing with other major crops in the region. Increased global demand for feed and fodder and the demand-supply gap can be a comparative

advantage to ICRISAT in the future, and the MTP provides an opportunity to capitalize on this increasing demand. Our mandate crops have a strong comparative advantage in terms of health and nutritious food for the poor as well as rich. It has comparative advantage in snack food as well. ICRISAT has a wider role to play in building resilience against climate change, and MTP 2021-23 provides an opportunity for the same. Aligning our research agenda for the drylands with national development priorities in the regions will help achieve the development outcomes and intended impacts to achieve food and nutrition security, equity and food systems' resilience in the drylands regions of Africa and Asia.

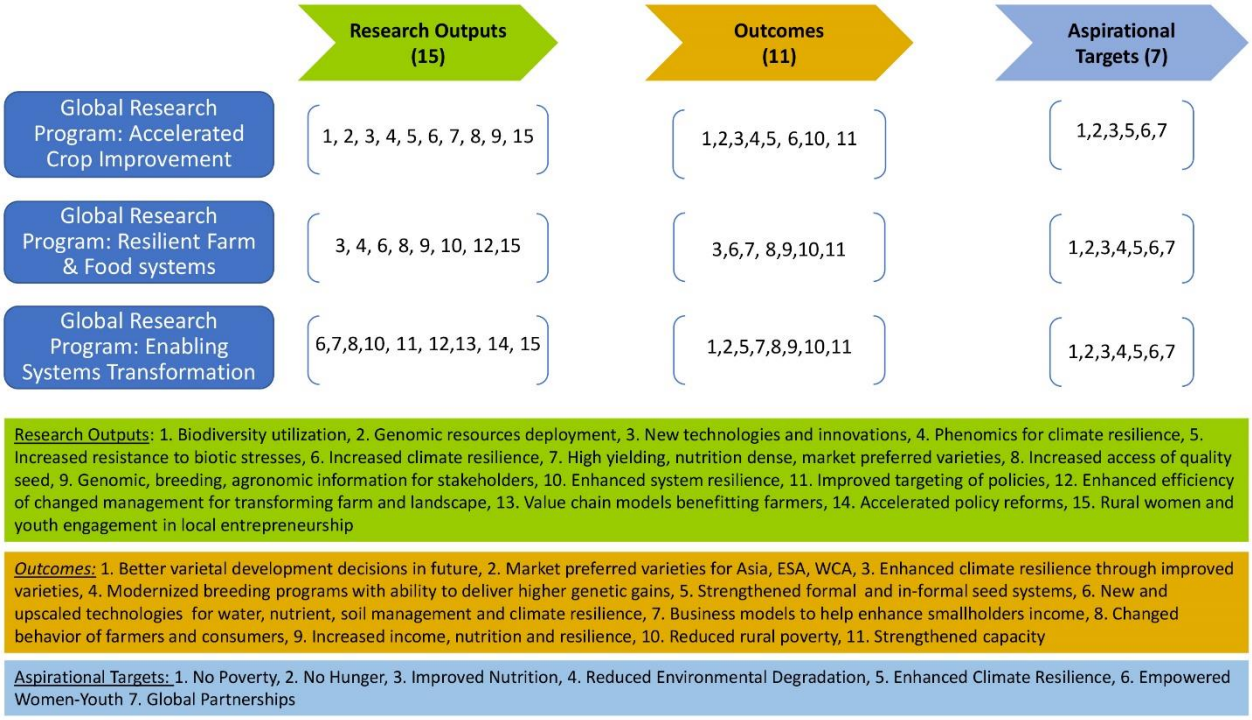


Figure 4: The research outputs, outcomes and aspirational targets of the three Global Research Programs.

7. International Public Goods

ICRISAT manages all the intellectual assets created as a result of its research activities in compliance with the CGIAR Principles on the Management of Intellectual Assets ("CGIAR IA Principles"). As per the policy, ICRISAT regards the results of its research and development activities as international public goods (IPGs) and is committed to their widespread diffusion and use to achieve the maximum possible access, scale, scope of impact on sharing of benefits to benefit the poor, especially farmers in developing countries. Towards this objective, ICRISAT publishes the results of its R&D activities as broadly and promptly as possible, including disseminating them on its online Open Access Repository (http://oar.icrisat.org/).

- ICRISAT's research products – Our improved crop varieties and hybrids, technologies and research tools have been designated as IPGs and are available without patent protection for the benefit of mankind across the globe.
- The innovations, methodologies, tools and other IPGs that have applicability across international boundaries.
- The mini core collection in ICRISAT's genebank is also an IPG and serves as a gateway for the utilization of plant genetic resources in crop improvement programs and with NARS partners.
- ICRISAT's Village Level Studies (VLS) conducted in Indian villages over four decades is an IPG and has proved to be one of the most valuable contributions to the knowledge base on rural household economies. The VLS datasets provide insights into the socioeconomic, agro-biological, and institutional constraints to agricultural development and are used globally by researchers and policy makers and by development actors in the drylands.
- Global and regional approaches to integrated natural resource management (INRM) with modest adjustments are employed for site-specific solutions in more than one country.
- Context specific climate advisory tool, many of such tools (e.g., ISAT being one of them) developed by ICRISAT, is being adapted in India as well as Africa.

8. Partnerships

To achieve its vision, mission and goal, ICRISAT adopts an Inclusive Market Oriented Development (IMOD) approach as part of its overall research strategy. The challenges facing the drylands are far too complex and varied for any single institution to handle; so, partnerships are central to our approach. ICRISAT partner for harnessing synergies to complement resources and share knowledge. We treat partners as respected equals, working shoulder-to-shoulder with them in an interdisciplinary manner from planning through to the execution and evaluation of joint efforts. ICRISAT partners with governments (national/state/local), academic institutions, foundations or trusts, international NGOs, local/national NGOs/civil society or groups, National Agricultural Research and Extension System (NARES), private industry, seed companies, Sub-Regional Organizations (SROs) and CGIAR centers. Annexure 2 lists the partners the three Global Research Programs are likely to engage with to implement the research initiatives. ICRISAT continues to implement programs on the ground by partnering with local organizations. ICRISAT shall also ensure equal participation of the poorest farming community. ICRISAT recognizes and reiterates the importance of collaboration with research institutions, agriculture universities (AUs) and other government institutions in different countries to bring together expertise that takes research results to the doorstep of poor farming communities. We will continue to strengthen our collaborative activities during the plan period and strengthening South-South cooperation by collaborating with NARS in different countries of Asia and Africa. ICRISAT shall continue to work closely with the host country NARES through the Department of Agriculture in each of the countries where ICRISAT is hosted as well as in the program implementation countries. Regional organizations such as the Indian Council of Agricultural Research (ICAR), Department of Agriculture & co-operation, Alliance for a Green Revolution in Africa (AGRA), Asia-Pacific Association of Agricultural Research Institutions (APPARI), South Asian Association for Regional Cooperation (SAARC), Association of Southeast Asian Nations (ASEAN) are our key partners as are farmers' organizations and communities.

ICRISAT has strong linkages in genomics and molecular biology research with multiple institutions such as the Chinese Academy of Agricultural Sciences (CAAS); University of Georgia, USA; University of Leeds, UK and University of Queensland, Australia. Our key collaborators on systems modelling and climate smart agriculture have been Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia; Wageningen University & Research (WUR), Netherlands; AgMIP a global partnership, India Meteorological Department (IMD) and Indian Institute of Technology Madras (IITM) besides NARES and agri-tech start-ups. ICRISAT's genebank is developing partnerships and enhancing the capacity of NARS partners in managing germplasm collections. It has intensified innovative partnerships with the private sector through its HPRCs, Agribusiness and Innovation Platform (AIP), Agri-Business Incubator (ABI) and i-Hub. Following the success of the HPRC in India, we have expanded the initiative to ESA with the objective of promoting the development of a diverse range of hybrid parental lines and cultivars of sorghum and pearl millet and sharing quality seed materials with stakeholders to help them develop, test and disseminate the seed and seed quality materials of cultivars sorghum and pearl millet hybrids that are highly productive in different agro-ecological zones.

9. MTP Links to Institutional Financial Plan

ICRISAT will engage actively with donors, national governments, public-private sector institutions, and philanthropists to generate funding support to implement MTP 2021-23 initiatives. It shall focus on large, commissioned grants through the development of strong relationships with donors to achieve the targeted delivery on farmers' fields and at policy levels while promoting young scientists to generate new technologies through bilateral programs collaborating with national partners in Asia, ESA and WCA. Compelling cases will be developed for ICRISAT's research around nutritious millets and legume crops and crop-livestock systems to build climate-resilient farm and food systems critical to achieving the SDGs 1 (No Poverty), 2 (Zero Hunger), and 13 (Climate Action) while contributing to 5.b (Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women) and 17.6 (Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation).

Budget (in USD million)

Year	Research areas/Budget							
Global Program: Accelerated Crop Improvement								
	Genebank	Genomics, pre-breeding and bioinformatics	Cell & molecular biology and trait engineering	Crop physiology and modelling	Crop protection and seed health	Crop breeding	Seed systems	Total
2021	3.664	2.563	0.810	1.600	2.730	14.703	5.663	31.733
2022	3.847	2.691	0.851	1.680	2.867	15.438	5.946	33.320
2023	4.040	2.826	0.893	1.764	3.010	16.210	6.243	34.986
Global Program: Resilient Farm and Food systems								
	Climate adaptation and mitigation	Landscapes, soil fertility and water management	Geospatial and big data science	Digital agriculture	ICRISAT Development Center			
2021	3.611	2.197	0.989	1.162	3.120			11.080
2022	3.792	2.307	1.039	1.220	3.276			11.634
2023	3.982	2.422	1.091	1.281	3.440			12.216
Global Program: Enabling Systems Transformation								
	Nutrition, dietary behavior and Smart Food	Technology adoption and impact analysis	Markets, institutions and policy	Gender and youth	Agribusiness Innovation Platform	Knowledge and capacity development		
2021	0.916	1.130	1.400	0.440	2.000	0.762		6.648
2022	0.962	1.187	1.470	0.462	2.100	0.800		6.980
2023	1.010	1.246	1.544	0.485	2.205	0.840		7.329
Research Support Services								
	Crop Improvement Operational Team Facility	Precision phenotyping for biotic, abiotic stresses and nutrition	Sequencing & genomics services	Rapid Generation Advancement	Farm services	Data management		
2021	0.300	0.500	0.300	0.500	0.500	0.500		2.600
2022	0.300	0.500	0.300	0.550	0.500	0.500		2.650
2023	0.33	0.55	0.35	0.6	0.5	0.5		2.830
Total budget								
2021								52.061
2022								54.584
2023								57.361

10: Risk Assessment and Adaptive Measures

ICRISAT has decided not to be part of the One CGIAR Governance structure though we will continue working in partnership with other CGIAR institutions, including One CGIAR initiatives. COVID-19 uncertainties have led to poor economic conditions of many nations and greater focus on health-related issues by many of the major donors; these pose challenges to resource generation for the next one or two years. ICRISAT will continue to strive to work closely with One CGIAR institutes as their partner while at the same time exploring opportunities to revisit and expand its mandate, especially for commodities in drylands as well as towards a demand-driven agenda. A well-defined pathway with different strategies than in the past will be needed to attract the attention of donors. Appropriate and effective communication with donors, partners and clients to continuously position the institute as a frontrunner and a global leader in agricultural research for development contributing to building sustainable food systems in the drylands of Asia and Africa independently of One CGIAR will be the defining crux of the strategy. The

COVID-19 disruptions globally could lead to diversion of resources to rebuild livelihoods. There is a risk of resources for conventional research drying up in the short run, calling for a more flexible approach to support research post-COVID (green) towards the recovery of farm and food systems. Also, in these uncertain times, there might be a risk of attrition of key staff, which would need clear prioritization and open communication with staff. The present change in status may result in a change in priority of some traditional donors towards ICRISAT, affecting the success of proposals. This will necessitate a re-planning of resource mobilization and diversification of funding with more emphasis on diversifying our resource allocation to different countries, governments and donors.

ICRISAT will adopt strategies to emerge as the leader for research for development needs in the drylands. National governments in the less developed areas of the drylands of Asia and Africa have major concerns about the status of their people. ICRISAT will engage with these national governments strategically to generate resources to implement the local adaptive research components of MTP 2021-23. Direct engagement with different countries will help generate more resources than the institute has been able to generate in the past. ICRISAT will need to diversify its donor portfolio and engage with new donors interested in investing in the drylands to improve the livelihood of smallholder farmers and consumers. Similarly, it will strengthen its engagement with the Asian Development Bank, African Development Bank, International Fund for Agricultural Development, Islamic Development Bank, and SAARC Development Fund in their loan and grant programs as technical partners in different countries. This process will also involve ICRISAT mapping different donor priorities to aligning with its own priorities, without much deviation from its own mandate; helping donors develop their agenda for funding; preparing strategy papers in key areas as per donor priorities and influencing to drive their priorities; connecting with large corporates, many of whom have started funding research and development; approaching new philanthropic organizations; contacting high net worth individuals; utilizing privileges in income tax donations; tapping corporate social responsibility funds; developing consortia and partnerships with the private sector; and involving its own facilities, senior staff and Governing Board members to generate resources. A targeted resource generation strategy with a focus on the challenges during the pandemic and post One CGIAR decision has been developed to meet the needs of the institute.

11. New Research Structure

To implement the research MTP 2021-2023, ICRISAT's current structure will need to be aligned to deliver global research program outputs in the regions. Its current research structure will need to be aligned with minimum changes in the reporting line of the staff while structurally aligning our staff to ensure the efficient delivery of outputs as a team.

The current research structure consists of two global programs and three regional research programs implemented through 21 themes, with data management and genebank areas reporting directly to the Deputy Director General – Research (DDG-R). These programs were:

1. Research Program on Genetic Gains
2. Research Program on Innovation Systems for the Drylands
3. Research Program Asia
4. Research Program West and Central Africa (WCA)
5. Research Program Eastern and Southern Africa (ESA)

Over the years, as research under different programs evolved, some weaknesses have been identified in the current research structure. One of the most visible weakness has been the inability of the research structure to closely knit global research programs with the regional research programs. Research on genomics, trait discovery and trait development as part of the Research Program on Genetic Gains has a very loose connection with crop breeding. Interestingly, the three regional research programs follow three different structures based on local staff availability. For instance, the Asia Program possesses five themes, and ESA and WCA have four themes each.

Some time ago, as part of the recommendation by the Breeding Program Assessment Tool (BPAT) team, ICRISAT tried to provide a global structure to its breeding program. The positions of Global Head - Breeding and Regional Breeding Leaders were added to the structure. However, global breeding programs cannot be implemented in totality unless there is a holistic change in the structure that brings together the genebank, genomics research, trait development, trait introgression, crop breeding, physiology, disease/insect resistance, multilocation testing and seed systems. In the current research structure, data management at ICRISAT is fragmented into several areas, with some managing data in their own way without any connection to ICRISAT's main data management theme.

Similarly, research on monitoring, learning and evaluation, impact assessment, markets, gender, and women and youth is fragmented into different global and regional research programs with scant or no connection and exchange of knowledge between them, thereby creating an environment of working in silos.

ICRISAT proposes a new organizational research structure consisting of three global programs implemented through 18 research clusters (Figures 5a and 5b) with support from the three Regional Directors of Asia, ESA and WCA (Figure 5c). From 2021, we embark on a new journey to emphasize the need for enhanced support for research in the drylands of Asia and Africa to positively impact the livelihoods of smallholder farmers through research in the areas of climate resilience, environmental degradation, nutrition, product concept-based holistic modernized breeding, strengthened seed systems, soil-water management, crops-livestock diversification, income-creating opportunities, women's empowerment and youth integration.

The proposed structure shall consist of three global research programs:

1. Research Program on Resilient Farm and Food Systems
2. Research Program on Accelerated Crop Improvement
3. Research Program on Enabling Systems Transformation

Leading the regions will be three regional directors:

1. Regional Director, Asia
2. Regional Director, East and Southern Africa
3. Regional Director, West and Central Africa

These three global research programs will operate through 18 research clusters, each cluster representing research activities in the same/similar research areas. The regional director will have the responsibility to ensure that global research programs are implemented efficiently in regions and are provided with the support needed. These global research programs will represent ICRISAT's arm of the 'science of discovery' through the implementation of foundation, translational as well as applied research.

The new research structure has been developed after thorough consultations with senior management, current theme leaders as well as the scientific and technical staff of each of the current five research programs. In this structure, staff will have a disciplinary 'home' to work, irrespective of the project they are working with. The new structure provides new opportunities for ICRISAT to extend its 'science of delivery' arm in ESA and WCA by extending its activities on the Agribusiness Innovation Platform, ICRISAT Development Center, and Knowledge and Capacity Development cluster. This will create more opportunities for ICRISAT's research impact in the drylands of ESA and WCA, while also linking Asia more closely with ESA and WCA through South-South cooperation programs.

In the new structure, the Program Directors for the three global research programs can be stationed either at ICRISAT headquarters or in their respective (ESA/WCA) regions. Research Cluster Leaders will be spread across Asia, ESA and WCA, based on the size of the program and the expertise available in the regions. The Regional Directors will be stationed at Hyderabad, Nairobi and Bamako.

Roles

The new research structure assigns a matrix reporting structure for staff between Global Program Directors and Regional Directors.

Global Research Program Directors are expected to devote 80% of their time in program management across regions, resource mobilization, research administration, and staff performance monitoring, and 20% of their time with research, mostly supervising scholars or, in some cases, as leaders of research clusters. Research Cluster Leaders will report directly to their respective Global Program Directors, with 40% reporting to Regional Directors of the region of their posting in the matrix structure. The annual workplan setting and year-end performance appraisal for Research Cluster Leaders will be carried out jointly by the Global Program Director and the Regional Director. Global Program Directors will not take up the role of principal investigators of projects, but they can be program co-ordinators for large projects that may run across several research clusters in a program, or across two or more global research programs.

Regional Directors will be responsible for the management of ICRISAT's support centers in Asia, ESA and WCA, in addition to managing regional and country relationships with support from five country representatives. The Regional Directors of ESA and WCA will be the Country Representatives for Kenya and Mali, respectively. Regional Directors will allocate 60% of their time to resource mobilization, developing innovative funding strategies for the regions and supporting project implementation in the regions. Developing new relationships and strengthening current ones will constitute 20% of their time, and another 20% will go to monitoring staff performance, administration and travel in the regions.

Research Cluster Leaders will devote 20% of their time towards managing their own staff as well as the staff in the research cluster across the regions, and 80% of their time towards research, resource mobilization and project development. They can be principal investigators of a project and should be the preferred principal investigators for projects across regions. To provide a defined path for leadership development, the role of Research Cluster Leader can follow a rotation with a tenure of three years, provided there exists comparable talent in the cluster.

Scientists in each cluster will devote 15% of their time in management of staff within the region and 85% of their time towards research, resource mobilization and project development. They can be principal investigators and should be the preferred principal investigators for region-specific projects.

Country Representatives will devote 40% of their time towards relationship building, resource mobilization, and support development, and 60% of their time on research. They can be principal investigators in region- or country-specific projects.

Research Leadership Team

To enable effective decision-making processes in research (including creating new opportunities), in the new structure decisions will be implemented through the Research Leadership Team that was created on 18 February 2021 through a memorandum from the Director General, ICRISAT. The Research Leadership Team will now include the DDG-R, the six Research Program and Regional Directors, Director of CGIAR Research Program (CRP) on Grain Legumes and Dryland Cereals, Cluster Leader for IDC and the Business Development Director, to:

- Effectively work together to drive the future of ICRISAT's research
- Provide strategic and operational leadership to ICRISAT's research
- Develop a future research strategy and ensure its effective execution
- Make decisions on prioritized research areas for ICRISAT in view of global and regional challenges in the drylands in terms of food and nutrition security, climate resilience, environmental degradation and enhanced incomes for farmers and other stakeholders
- Work closely with the business development team and take quick collective decisions on funding opportunities
- Develop and explore innovative funding opportunities, including unconventional approaches
- Make decisions on the placement of projects in programs, assign principal investigator and project team for the development of the concept note and full proposal
- Ensure high quality research by different project teams, and review project implementation
- Monitor project planning, management, progress, reporting and completion of research
- Ensure adherence to external financing guidelines
- Develop guidelines and procedures to review ICRISAT research and R4D publications, including manuscripts, book chapters, books and review articles.

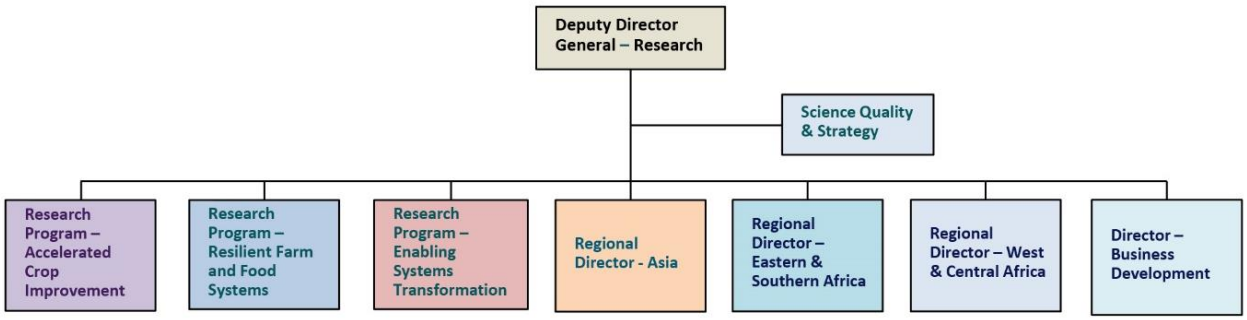


Figure 5a: Overall research structure

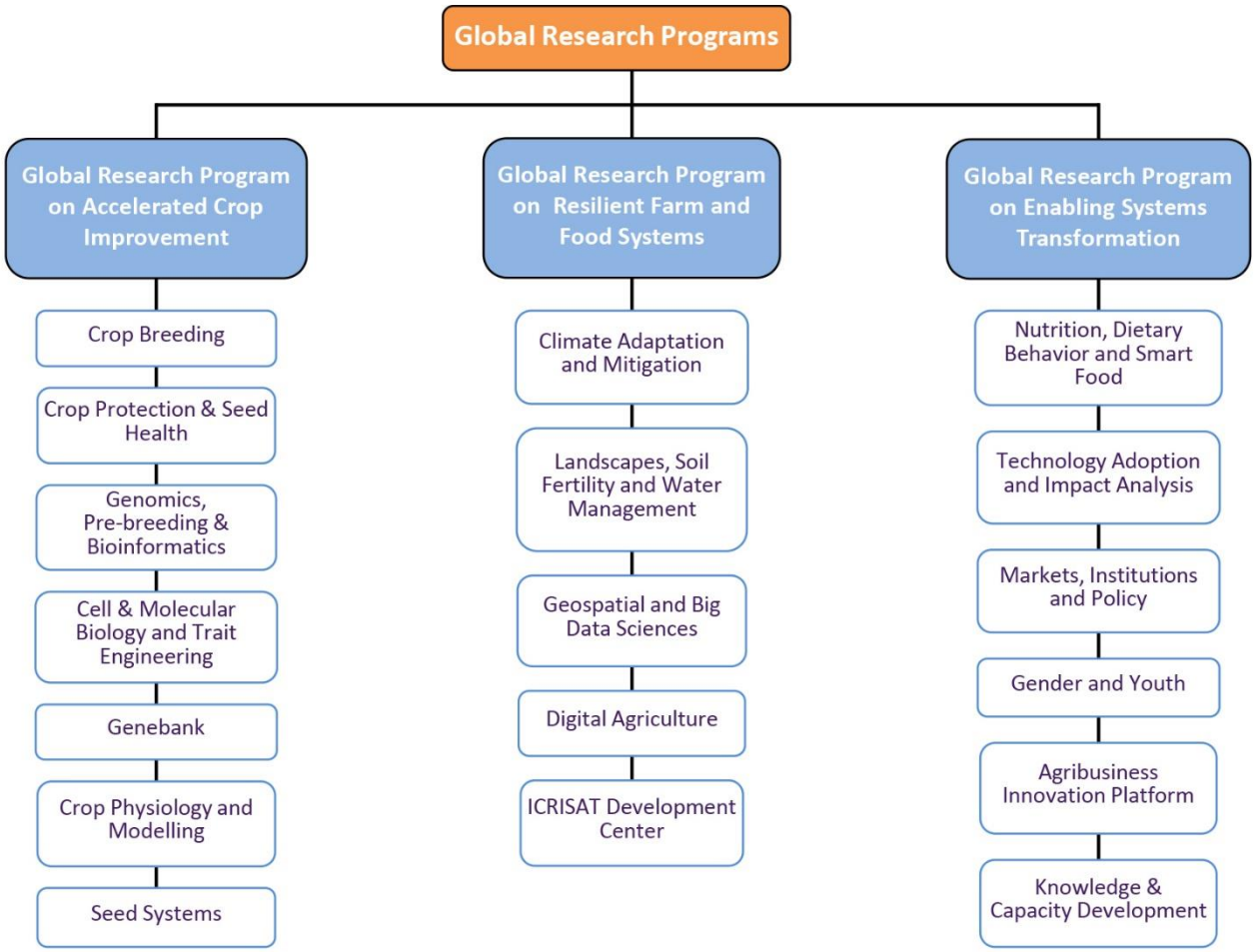


Figure 5b: Structure of the three global programs

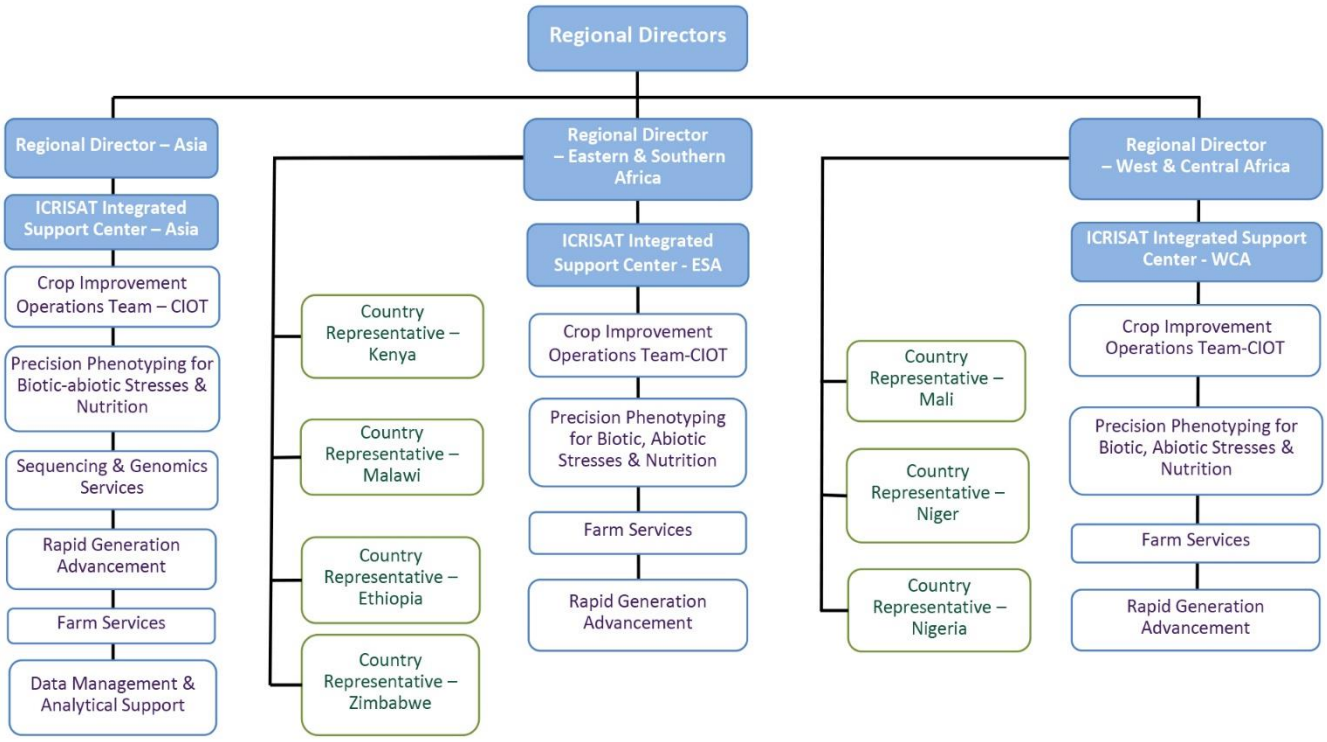


Figure 5c: Structure of three regional directors and seven country representatives across three regions.

12. Research Support Services

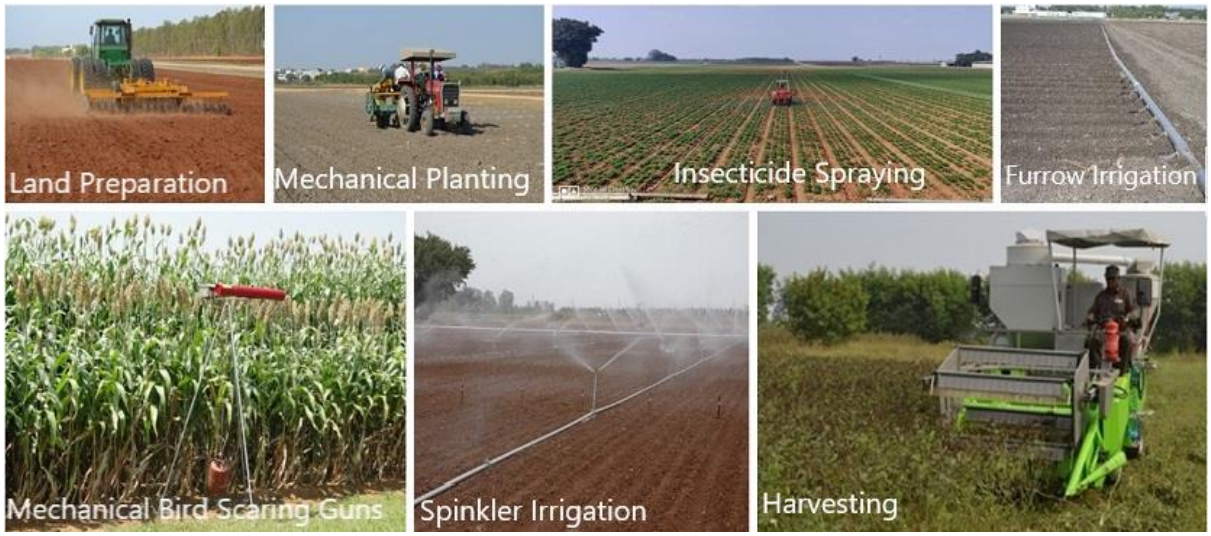
Modernized research facilities and tools enabling implementation of the MTP

Implementation of the research activities of MTP 2021-23 will need mechanized farms as well as modern operations facilities in the field, laboratory as well as for data management in all the three regions. Some of these facilities have been developed and others are in the process of being mechanized. During 2021-23, ICRISAT will undertake an upgrade of some of the facilities, streamline the services of others as well as establish new facilities such as the one for Rapid Generation Advancement for speed breeding.

1. Farm & Engineering Services (FES)

The Farm and Engineering Services is a research support unit that provides facilities for the development, operation and maintenance of fields, controlled environment experiments and infrastructure on the campus to facilitate the smooth and efficient functioning of the institute.

FES provides a range of services in both farm and engineering operations. On the farm, it includes land development and farm structures; tillage, harvest and post-harvest operations; irrigation, drainage and labour operations; plant protection and surveillance; controlled environment research facilities and landscaping. On the engineering side, it provides support in civil works, plumbing and carpentry; electronics and instrumentation; electrical, air-conditioning and refrigeration; automobile, heavy machinery and fabrication; janitorial services for the upkeep and maintenance of the campus; mailroom, courier and postal services, and EPABX telephone board operations. The cluster works on a cost recovery basis. The major cost recovery comes from crop cost charges, space charges, inter-program billing for work requests, bulk users of power and water, split air-conditioning usage charges, landline usage charges, postal and courier charges, revenue generation through the sale of fish and orchard produce, long term land use, controlled environment research facilities and farm machinery and seed drying billings. FES will need some investment to modernize its machinery as well as to purchase new equipment.



2. Crop Improvement Operations Team (CIOT) in India, ESA and WCA

A centralized Crop Improvement Operations Team (CIOT) created at ICRISAT headquarters supports operations of the breeding program at headquarters and functions on a cost charge basis. CIOT follows standardization of processes and mechanization of operations resulting in resource optimization while enhancing data quality. Its clients include all breeding units, genomics unit, crop physiology, integrated crop management and seed companies (external). The services provided include seed-to-seed crop improvement operations (planting to harvesting, pre & post-harvest data collection, processing, storage and seed inventory (cold store management). CIOT also handles all greenhouse experiments for its clients. The quality of service is maintained through standardization (following standard operating procedures (SOPs)/ revising existing SOPs/ making new SOPs), continuous improvement (through regular feedback from clients) and technical upgrades (new technologies and training). A Business Plan has been developed factoring the actual cost of all crop improvement operations during 2019. The newly constructed Seed Processing Facility is the mechanization arm of the seed processing unit. A similar CIOT facility is being developed at the breeding hubs in ESA and WCA and shall be functional during the 2021-23 MTP period.

3. Sequencing & Genotyping Services (SGS)

To cater to the needs of genotyping and sequencing requirements to accelerate research and modernize crop improvement programs at ICRISAT and among partners, a single window facility will support the sequencing and genotyping needs of ICRISAT and for partners. SGS shall support different research programs at ICRISAT, NARS partners/ small-medium size companies in Asia and Africa. It will contribute to enhancing genomics applications in disciplinary research and breeding applications at ICRISAT and partner institutes. More than 40 institutes, universities, foundations, private companies from more than 15 developing countries in Africa, Asia and South America have availed/ are availing these services in 34 crops. The facility uses HiSeq 2500, MiSeq, ABI3730, ABI RT-PCR, Tecan Liquid Handling and Automation and a high-performance computational analysis platform with 600 cores, 6 TB RAM and 830 TB storage. Its key services include whole genome sequencing, Genotyping-by-sequencing (GBS), Transcriptome sequencing (RNA seq) and small RNA sequencing, SSR genotyping, Metagenome sequencing, qRT-PCR assays, DNA isolation, basic genome and transcriptome analysis, sequence alignment and variant calling, GBS analysis for molecular mapping, diversity analysis and genome wide association study (GWAS). Internal and external users will include scientists from various Clusters of all the Research Programs of ICRISAT across the regions (Asia, ESA, WCA), ICRISAT-hosted institutes (The World Vegetable Center, CIMMYT-India, IRRI-India) at Patancheru, NARS partners and small and medium size companies in Asia, Africa and South America and international collaborators.

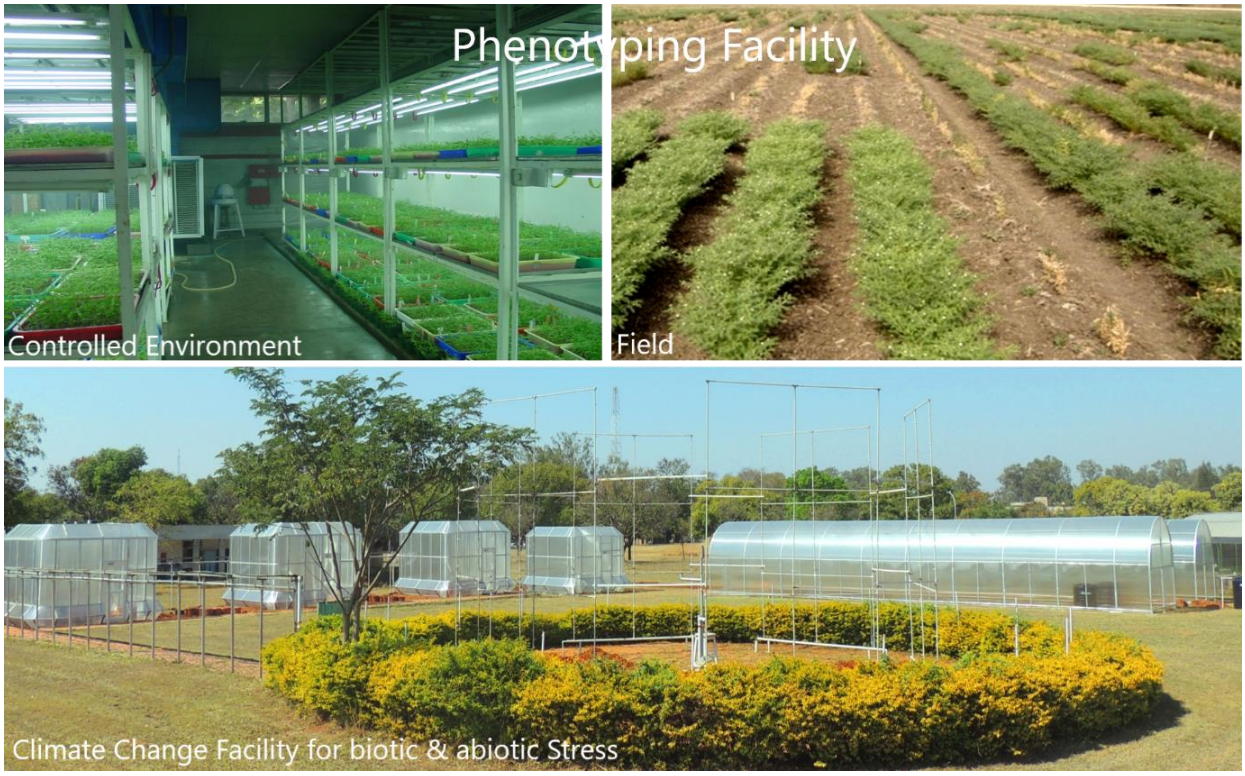
4. Rapid Generation Advancement (RGA) facility

ICRISAT's state-of-the-art Rapid Generation Advancement (RapidGen) facility will be unique in the public sector in India. It will support crop improvement-related generation advancement in crop breeding and enable speed

breeding. Rapid Generation Advancement accelerates the plant's breeding lifecycle and shortens the variety release pipeline by several folds. Reducing breeding cycle time with RGA in breeding programs will enhance rate of genetic gains. The facility helps plants reach maturity at a much quicker pace than under field conditions. It can also be used for off-season nurseries and genomic selection and will reduce the breeding cycle time by almost up to 40% or more in most species. The facility can accommodate 28,000 plants at a time for cereals like pearl millet, sorghum and 2,520 plants of groundnut. ICRISAT plans to double this facility in next two years and quadruple it in the next three years through PPP and collaborative funds. The facility is available for use by both internal and external (NARS and other organizations) collaborating agencies. As of now, 75% of the facility will be reserved for internal use and 25% for external use. This service runs at zero profit and services charged based on expenses incurred on actuals and maintenance.

5. Phenotyping of plant biotic stresses

ICRISAT envisions to create a state-of-the-art phenotyping platform using automated phenotyping technologies to screen for biotic stresses for important diseases/traits of ICRISAT mandate crops. The phenotyping facility will address current needs for advanced phenotyping methods which are critical for the development of climate-smart crops and cropping systems and to ensure food security and environmental sustainability. To promote multi-disciplinary research and partnerships/collaborations, and to duplicate the phenotyping setup in other ICRISAT locations the phenotyping team will engage with several internal and external stakeholders. The facility will mainly cater to ICRISAT's crop improvement breeding for disease resistance by phenotyping for various diseases and pests of ICRISAT's mandate crops and accelerate the variety development process. The facility will also support NARS, SAUs, other CGIAR centers and private seed companies in phenotyping for disease resistance. There are plans to set up such phenotyping facilities in ICRISAT locations in ESA and WCA. In the long run, it will offer opportunities for corporate R&D departments to carry out high-throughput plant phenotyping to study plant performance in relation to biotic stresses across a range of scales, from cell to field. A dedicated team will oversee the scientific and strategic management of the facility and a business strategy will be developed.



6. Phenotyping for abiotic stresses and nutrition

The phenotyping facility for abiotic stresses and nutrition shall support ICRISAT's research on trait development, crop breeding and climate resilience through standardized phenotyping for abiotic stresses - mostly drought and drought-related agronomic traits using the following advanced phenotyping protocols:

- LeasyScan for precise high throughput assessment of environmental adaptation (heat, drought, salinity) that shall generate data on early vigor and crop establishment rate, transpiration efficiency components, heat stress growth response, salinity stress growth response, canopy structure/radiation capture, biomass quality, diseases screening
- LysiField for precise medium throughput assessment of environmental adaptation (heat, drought, soil type and soil fertility) to generate data on grain and biomass yields, transpiration efficiency (TE), water use efficiency (WUE) and plant water use (total and dynamic)
- UAV-based field monitoring system being set up for high throughput assessment of crops' agronomic traits to measure grain and biomass yields, leaf area index (LAI), biomass growth rate, flowering time, plant height, panicle count, plant count and stay-green (and other abiotic stress-related traits).

A facility for exploratory research on nutrition shall provide services for precise high-throughput assessment of crop nutritional traits, contaminants and traits related to market value. The facility will generate data on grain and biomass organic and inorganic composition, as well as physical properties of grain linked to market value. The expected output from the facility are generation of standardized data on traits and partnerships and knowledge for effective platform design and available databases for the future. The facility will link closely with internal and external stakeholders such as the CGIAR, EiB, ICRISAT-hosted centers, NARS, and global public-private research institutions.

7. Data Management and Analytical Support (DMAS)

With a view to ensuring better research quality, repeatability and cost-effectiveness by leveraging modern data science, this cross-cutting unit will provide high-quality data science support to agricultural researchers, enabling them to make informed decisions. It will provide end-to-end research data support including research/study design, digital data collection, databases for managing research data, high quality analytics, genomic selection and help in achieving higher genetic gains. DMAS will also assist in applying FAIR principles to research data sets and make them open access. Its team of well experienced data scientists have expertise in modern statistics, biometrics, computational algorithms, quantitative genetics, statistical computing, and the incorporation of methods and platforms to ensure a strong data ecosystem. We embrace advanced statistical approaches to the production and implementation of new methods to advance breeding research decision making. DMAS shall mainly collaborate with all ICRISAT research units across all locations. It will also work extensively and collaborate with various NARS and CGIAR platforms in providing data science support in the areas of biometrics and statistical genetics and provide reliable statistical backstopping to multidisciplinary teams of researchers during the research cycle.

13. Corporate Support Functions

Background

Corporate support functions are key enablers of ICRISAT's success. They support the core business of ICRISAT – agriculture research for development – and are aligned to support the efficient and effective delivery of organizational goals. A modern and efficient corporate services function can have a transformative effect on the core work of ICRISAT. The objective of the MTP for corporate services is not a business-as-usual approach but a transformative agenda to create more agile, responsive and forward-looking support. For example, in Communications, the shift has been away from traditional output-based indicators such as the number of publications and number of social media posts or likes, to outcome-based indicators such as 'establishing thought leadership' or 'influencing organizational culture'. Similarly, in Human Resources Services the focus is on excellence and innovation, deploying modern recruitment and retention strategies and enhancing overall work experience. The thrust of modernization is to enable 'any time' 'anywhere' delivery of services achieved through shifting much of our service delivery online. Some functions are already delivering online services, and in future more services will be available online and function in an integrated manner, improving employee experience and providing a seamless interface to ICRISAT corporate support services.

Communications

Overview and Rationale

1. Introduction

External communications cuts across all areas of ICRISAT and is critical to support the core business of undertaking research for development. Its role in research is multiple. Communicating about the importance and critical needs of the drylands is a core communications base. ICRISAT's work and impacts in the drylands is essential to attract funders and partners. Communications also supports wider awareness about the innovations, technologies and approaches developed and tested by ICRISAT, contributing to further uptake and ultimately impact.

Across all of this is the overall and consistent way ICRISAT is presented and hence positioned. The ICRISAT Strategic Plan positions ICRISAT as the partner of choice in dryland agriculture, which should be reinforced through all communications and supported by the value proposition of ICRISAT as presented in the Strategic Plan. This also requires corporate level communications to brand ICRISAT and ensure consistent use and reflection in all outputs and activities.

External communications also supports the recruitment of high quality staff in the way the organization's mission and work are presented as well as the reflection of the 'personality' of the organization and its people.

These varied functions of external communications are critical to the success of the institute, and directly impact positively on the funding, attracting partners and staff and the uptake of research.

ICRISAT's approach to communications will be two-fold, including broad communications to reach as wide an audience as possible, and targeted communications aligning with specific targets of influence and engagement. Digital tools and innovative and creative approaches will be necessary to reach audiences and stand out in the crowded information space.

Internal communications cuts across the whole institute, all geographies, Programs and levels of staff, facilitating communications in all directions – up, down and across. Internal communications should facilitate knowledge sharing, especially to support better decision making and creating a transparent, positively engaged work environment. With innovation at the core of our work, internal communications can play an important role to assist in creating a culture conducive to this.

2. Highlights of the MTP

External Communications

External communications have two overall outputs to focus on: increased awareness about ICRISAT's work, targeting the full range of collaborators; and to be established as a thought leader, particularly targeting policy makers and influencers.

Increased awareness about ICRISAT's work' includes current and future collaborators, and can broadly include, for example, funders through to researchers, the private sector, development agencies, policy makers, civil society and the media.

A full range of ICRISAT communication tools, channels and campaigns will be used. Digital and modern approaches will be applied, and all activities strategically selected to ensure maximum benefits from resources used.

The 50th Anniversary in 2022 will form a base for a wide range of communications that will highlight ICRISAT's past 50 years of innovations, scaling out and impacts, while focusing strongly on what we intend to do in the next years. This should be leveraged strongly in 2022 but also for the following years.

The International Year of Millets in 2023 (broadly defined to also include sorghum) will also be important to engage with and leverage to highlight ICRISAT's strong expertise and work in millets and sorghum. Along with the successes, future research priorities will be promoted to more closely link communications with fundraising efforts.

The outcomes expected are ICRISAT's increased engagement with key stakeholders and growth in ICRISAT's brand recognition. This will result in ICRISAT becoming the partner of choice in the drylands and the employer of choice for world class researchers.

Awareness is built though all the communications efforts which complement the roles all staff have in promoting ICRISAT and its work. As a result, it is difficult to attribute impacts to specific communication activities. Quantifiable targets are possible through the digital media which can be representative of the overall reach of ICRISAT. However, it is encouraged that when specific activities are undertaken, an ad hoc analysis, e.g. a survey, may be undertaken to gauge the effectiveness of the communications and gather feedback for input into future communications.

The regular output targets that will have quantifiable targets set include new unique visitors to ICRISAT website and higher engagement on social media. These are impacted not only by overall impact of efforts to raise awareness about ICRISAT but can show immediate and direct impact of specific activities.

Output 2 'Thought leadership established' is important among all audiences and stakeholders and especially targets policy makers and influencers.

ICRISAT will leverage key international events and topical issues to position itself as a thought leader. International events will be tracked through our own networks and topical issues tracked through media. These will be strategically selected to ensure ICRISAT's involvement. ICRISAT will also initiate a 'State of the Drylands' analysis and publication, to position itself as a thought leader on agricultural issues in the drylands. This will be further enhanced and detailed over time, building the knowledge and insights.

The outcomes expected are a positive perception of stakeholders about ICRISAT's thought leadership role, and potential stakeholders positive about collaborating with ICRISAT.

The overall impact should lead to ICRISAT's innovations, approaches and issues being advocated and adopted more widely by influencers and overall ICRISAT's reputation being enhanced. Ultimately this is a major contributor to ICRISAT attracting more funding to undertake its mission in the drylands.

To quantify this the output targets are set for senior leadership of ICRISAT invited to participate in policy shaping dialogues, and the engagement of critical stakeholders with senior leadership of ICRISAT increases. These outputs can be collated and tracked. It is also recommended that occasional stakeholder surveys should be undertaken to have a deeper and qualitative understanding of ICRISAT's reputation as a thought leader. This can be aligned with strategic needs.

Internal Communications

The first year of the MTP will see tremendous internal change for ICRISAT, including a significant proportion of the management team being new, a new Strategic Plan and a new structure. This places even more importance on internal communications and a more flexible approach to the areas selected to focus on for internal communications. It is recommended that the priorities for internal communications also be guided by a staff survey to identify the largest concerns of staff that are key to the implementation and success of the Strategic Plan; internal communications can play a critical role. This will also provide a baseline to monitor and judge success.

Internal communications planned at this stage will focus on two outputs, i.e., to increase employee engagement and to influence organizational culture. The 50th Anniversary in 2022 will be leveraged not only for external communications but also to build engagement and pride among staff. This should be leveraged strongly in 2021, in the 50th Anniversary year 2022 and also in the following years.

The outcomes aimed to be achieved are increased staff motivation and for staff to feel they have a voice and their voice is heard. The ultimate impact is for improved productivity and staff morale.

A major challenge are the many influences on these outcomes and desired impacts. This will require a sophisticated approach to track not only targets but also the influences. The attribution of the efforts for internal communications should be assessed where possible. This can be tracked through staff surveys which could be incorporated in staff surveys undertaken by Human Resources.

The key target for internal communications will be employees' increasing engagement with the organization. Areas of engagement will be identified and then tracked over time.

The second output of internal communications is to influence organizational culture. This is influenced by many areas and initiatives, and especially the responsibility of all senior staff from the Director General through to the executive leadership team and the research leadership team.

There are two desired outcomes that internal communications will focus on. Firstly, it will foster increased collaboration between units and departments. This output will be reviewed carefully and designed around the new structure while identifying the most challenging and critical collaborations.

The second outcome will be that staff feel empowered and go the extra mile. The overall impact desired is the increased sense of alignment and commitment towards organizational goals.

Staff surveys have shown a consistently strong staff commitment to the ICRISAT mission. This has been a key factor influencing staff to continue at ICRISAT. The staff's strong motivation can be leveraged to ensure that they are empowered to go the extra mile to fulfill their roles as part of the mission. Internal communications has a key role to play in this.

How the institute succeeds in empowering staff to go the extra mile will be ascertained by measuring the gap between the current culture and desired culture. This gap should be decreasing and can best be measured through staff surveys. It will be important to identify how internal communications are contributing towards this as well as other influences.

The ICRISAT Strategic Plan will be key in guiding the inculcation of the desired culture. The key culture parameters are: inclusive, accountable, performance driven and people-centric. Internal communications strategy and activities will need to be built around these parameters. Measurement of effectiveness will be in the form of tracking the values as well as the attribution of internal communications to these. This can be aligned with the regular Human Resources staff survey which should also identify the baseline of the culture to be able to measure future progress.

Logical Framework for Communications: Major outputs, intended users, outcomes and impacts

	Output Targets	Intended users	Outcomes	Impacts
External Communications				
Output 1: Increased awareness about ICRISAT's work – leveraging a wide range of communication tools and activities including ICRISAT's 50th Anniversary and the International Year of Millets				
2021	New unique visitors to ICRISAT website (25% increase over 2020) Higher engagement on social media (25% increase over 2020)	Collaborators	ICRISAT's engagement with key stakeholders increased Growth in ICRISAT's brand recognition	ICRISAT is the partner of choice in the drylands ICRISAT is the employer of choice for top-notch researchers
2022	New unique visitors to ICRISAT website (50% increase over 2020) Higher engagement on social media (50% increase over 2020)	Collaborators		
2023	New unique visitors to ICRISAT website (100% increase over 2020) Higher engagement on social media (100% increase over 2020)	Collaborators		
Output 2: Thought leadership established				
2021	Senior Leadership of ICRISAT invited to participate in policy shaping dialogues (10% increase over 2020) Engagement of critical stakeholders with senior leadership of ICRISAT increases (20% increase over 2020)	Policy makers, influencers	Positive perception of stakeholders about ICRISAT's thought leadership role Potential stakeholders positive about collaborating with ICRISAT	ICRISAT's point of view is adopted more widely by influencers ICRISAT's reputation is enhanced

2022	'State of the Drylands' launched and promoted Senior Leadership of ICRISAT invited to participate in policy shaping dialogues (20% increase over 2020) Engagement of critical stakeholders with senior leadership of ICRISAT increases (40% increase over 2020)	Policy makers, influencers		
2023	Senior Leadership of ICRISAT invited to participate in policy shaping dialogues (30% increase over 2020) Engagement of critical stakeholders with senior leadership of ICRISAT increases (60% increase over 2020)	Policy makers, influencers		
Internal Communications				
Output 1: Increase employee engagement				
2021	Employees are more engaged with the organization (establish base line)	Employees	Staff motivation levels increase Staff feel they have a voice and their voice is heard	Productivity improves and staff morale is high
2022	Employees are more engaged with the organization (20% increase over base line)			
2023	Employees are more engaged with the organization (40% increase over base line)			
Output 2: Influence organizational culture				
2021	Gap between current culture and to-be culture is reduced (establish base line)	Employees	Increased collaboration between units and departments Staff feel empowered and go the extra mile	Increased sense of alignment and commitment towards organizational goals
2022	Gap between current culture and to-be culture is reduced (5% increase over base line)	Employees		
2023	Gap between current culture and to-be culture is reduced (10% increase over base line)	Employees		

Activities and outputs for ICRISAT 50th year events in 2022 and UN International Year of Millets in 2023				
2021	Discussions and development of the plan for events, engagements, symposiums, conferences for ICRISAT to put in place for 2022 in Asia, ESA and WCA. Interactions with Government of India, with different state Governments in India, different governments and institutions to gather ideas	ICRISAT, donors, partners ICRISAT, national govts, state govts., partners, stakeholders	Plan developed for 2022 events Ideas captured for 2023 events, initial plan developed	Greater visibility for ICRISAT
2022	Number of events including ICRISAT Board meeting, provincial- regional-international conferences, visits of farmers, partners, scientists, govt. officials, donors and stakeholders, discussion series organized at	ICRISAT, national govts, state govts., partners, stakeholders	ICRISAT 50th year establishment celebrated	Greater visibility for ICRISAT

	ICRISAT headquarter as well as at regional headquarters and country offices in Asia, ESA, WCA to celebrate ICRISAT's 50th year of establishment together with science backed extensive communications Discussions and development of the plan for events, engagements, symposiums, conferences for ICRISAT to put in place for 2023 UN International Year of Millets in Asia, ESA and WCA.	ICRISAT, national govts, state govts., partners, stakeholders	Plan developed for 2023 events	
2023	Number of events including provincial-regional-international conferences, visits of farmers, partners, scientists, govt. officials, donors and stakeholders, discussion series organized at ICRISAT headquarters as well as at regional headquarters and country offices in Asia, ESA, WCA to celebrate the UN International Year of Millets together with science backed extensive communications.	ICRISAT, national govts, state govts., partners, stakeholders	UN International Year of Millets celebrated together with different stakeholders	Greater visibility to ICRISAT

*Output targets adjustments with 30% budget reduction

Human Resources Services

1. Introduction

The Human Resources Services (HRS) MTP for 2021-2023 underlines the priorities and focus areas of the team required to support the institutional objectives specified in the ICRISAT Strategic Plan during a three-year period, through structured human capital development and transformation. This roadmap is inextricably linked to the institutional strategies and aims to deliver in tune with the changing needs and rising challenges. The key objectives of the plan will be consistent with the long-term vision:

- Driving excellence and innovation that leads to successful outcomes and propels the Institute forward while leveraging technology and remaining a financial steward
- Deploying recruitment and retention strategies, including branding and communication, to attract and retain talented and diverse individuals
- Investing in staff development and expanding the succession management programs
- Enhancing overall work experience through a culture of engagement, wellness, diversity and inclusion, that leads to overall employee well-being, productivity and retention.

The HRS MTP lays the foundation for the transformative journey of Human Resources to Human Capital to position our workforce not only as a resource but as a valued asset that constitutes the driving force of organizational growth and development. The plan also provides the roadmap to sustain this transformation through pragmatic change management and capacity development.

The plan strives to ensure that initiatives and engagements are primarily driven by the research objectives and institutional mission, to be achieved through active business partnering and synergies across different Human Resources functions and geographies.

The ICRISAT Strategic Plan identifies organizational culture, ethics and safeguarding, staff wellness, job equivalence and pay parity, talent acquisition and career development as key elements under Human Capital Management. The HRS Medium Term Plan details a work plan with four broad output target areas: i) Single Spine Initiative, ii) Performance Management and Career Development, iii) Employee Experience and Delivery and iv) Talent Acquisition, which encompass these key elements. The output targets will grow with every progressive year while dealing with a comprehensive range of Human Resources activities covering all the critical employee life cycle processes. The output targets will foster a high-performance culture and align with wider institutional strategies.

The HRS team will undertake continuous improvement of processes and technologies along with standardization of policies and frameworks throughout the three-year period and subsequently during the entire period of the Strategic

Plan. The team intends to position itself as a strategic delivery partner, constantly evolving with the new challenges in the dynamic environment and research mandate of the institute.

2. Highlights of the MTP

i) Single Spine Initiative

The Single Spine Initiative aims to rationalize the multiple employment contract modalities and build a progressively linear organizational structure through a job grading and job classification system. The modern organizational structure will be the foundation of all future people strategies and development initiatives. It will ensure that each job in the Institute is appropriately valued and positioned in the organizational hierarchy, which in turn will form the basis for similar pay for similar work. Additionally, it will address the existing structural issues of pay parity, inconsistent policy administration and undefined career path.

The primary vehicles of implementation of the Single Spine initiative will be the upgraded Human Resources Management Policy (HRMP) and Human Resources Administrative Procedures (HRAP). These documents will replace the existing Personnel Policy Manual and Personnel Administration Manuals. The HRMP and HRAP will detail standardized policies and procedures for the entire employee life cycle. Both documents will come into force in 2021. This will be supported by a comprehensive salary and benefits review to ensure benchmarking of the new job grades with external comparators. The adjustment to the new structure and policies will be supported through continuous communication and rollout of Standard Operating Procedures for all major HR processes throughout 2021 and 2022. The efficacy of the Single Spine structure and need for further improvements will be assessed through an internal management review in 2023.

Logical Framework of the Single Spine Initiative: Major outputs, intended users, outcomes, and impacts

Single Spine Initiative				
	Output Targets	Intended users	Outcomes	Impacts
Output 1:	**Implementation of the Single Spine structure and upgrades to policies**			
2021	Rationalization of multiple contract modalities to a progressive linear organizational structure Upgraded HR policies and practices disseminated through the new HR Management Policy and HR Administrative Procedures Compensation benchmark and benefits review for all locations	ICRISAT workforce	A linear organizational structure with strengthened policies, procedures, and compensation principles	Transition to the desired global model which encompasses standard policies for all geographies, pay parity for similar jobs and mobility across Programs and locations within the Institute
2022	Standard operating procedures for all major employee life cycle activities	ICRISAT workforce	Enhanced organizational capability with synergized workforce and efficient ways of working	
2023	Internal review to evaluate the efficacy of the new structure and policies, and measure deviation from the objective	ICRISAT workforce	Document the success and areas of improvement. If required, course correction and adjustments to ensure the objectives of the Single Spine Initiative are achieved.	

ii) Performance Management and Career Development

A Performance Management System ensures alignment of individual actions with organizational priorities while enabling growth and development for staff. The current performance management approach is mostly limited to performance measurement against qualitative and quantitative indicators. New challenges and the need for capacity development call for a strategic shift towards a modern and robust performance management system that would play a dominant role in career development by being integrated with succession planning, career progression and top talent management. The upgraded performance management approach will influence a high-performance culture leading to higher efficiency and productivity, while offering individual growth opportunities to staff. The system is intended to be agile to adapt itself to the unique needs of research and non- research areas. A balanced approach will be adopted to methodically transition the present approach and system, with a clear expectation of continuous improvement in performance standards and cascading processes.

The transition will begin in 2021 by linking performance management to skills-based career progression and succession planning. This will provide a defined career path and platform for tailored capacity development programs. Simultaneously, a Strategic Performance Management model will be developed, interlinked with skill gap analysis and training need identification, thus transitioning to a philosophy of 'active performance management' from the existing 'performance measurement'. The implementation of the new model in 2022 will be the next logical step. The goal in the latter half of the plan would be to stabilize the upgraded performance management system and foster an environment of coaching and mentoring which would help build the talent pool through focused interventions on leadership development, performance orientation, top talent recognition and succession planning.

Logical Framework of performance management and career development: Major outputs, intended users, outcomes, and impacts

Performance Management and Career Development				
	Output Targets	Intended users	Outcomes	Impacts
Output 1:	Modernisation of Performance Management System			
2021	Performance and skills-based career progression and succession planning	ICRISAT workforce	A defined career path and tailored capacity development programs	High performance delivery towards achieving ICRISAT's mandate, mission and vision
2022	Strategic Performance Management model developed, interlinked with skill gap analysis and training need identification	ICRISAT workforce	Transitioning to a philosophy of 'active performance management' from the existing 'performance measurement'	
2023	Stabilize the upgraded Performance Management system and foster an environment of coaching and mentoring	ICRISAT workforce	An identified talent pool through focused interventions on leadership development, performance orientation, top talent recognition and succession planning	

iii) Employee experience and delivery

An employee experience and delivery approach typically comprise of a number of transparent mechanisms and channels that facilitate a strong internal communication framework to enable an engaged, inclusive and interconnected workplace. The desired output is that all individuals work towards a common goal, and have several approved ways of delivering, sharing and accessing appropriate information to guide them in delivering the Institute's mission. This approach will provide globally consistent mechanisms and accountability for strengthening workforce engagement, workplace advocacy, wellness, diversity and inclusion and cultural harmonization. It will also create stronger linkages between teams, departments and individual staff members.

In this endeavor, an internal communication framework will be developed in 2021 for staff engagement and feedback to promote a stronger workplace understanding of policies and practices, and an increase in engagement. The framework will also provide strong support to the Ethics and Safeguarding framework and policies by pronouncing an expectation of organization-wide communication, providing a range of sustainable channels and assigning accountability for channel implementation. The internal communication framework will become fully operational in 2022 and be followed by an employee satisfaction survey in 2023 to measure the efficacy of the framework with a focus on organizational culture and the impact of modernization initiatives. The survey results will form the basis for future improvements.

Employee experience and delivery will be enhanced through a global diversity and inclusion strategy which will commit to a welcoming workplace that accommodates, respects and values people of all identities, abilities and life stages. It will integrate diversity and inclusion into the core values and competencies of the Institute through clear articulation in all Human Resources policies, procedures and guidelines. The development of the strategy will be completed in the 2021 and will be implemented by 2022. The framework will be further strengthened in 2023 through dissemination of designed knowledge tools and leadership training.

Logical Framework of employee experience and delivery: Major outputs, intended users, outcomes, and impacts

Employee Experience and Delivery				
	Output Targets	Intended users	Outcomes	Impacts
Output 1:	*Internal Communication Framework*			
2021	Develop an internal communication framework for employee engagement and feedback	ICRISAT workforce	A planned and coordinated workforce relations and wellness approach that is multi-channel, consultative, timely and transparent.	A healthy work culture that offers multiple avenues which can be accessed for effective communication, change management, grievance redressal, providing consultation forums, enabling collaborative problem-solving and cultural harmonization
2022	Implement the internal communication framework	ICRISAT workforce	An increase in workforce engagement, as individuals feel more connected to the Institute	
2023	Employee Satisfaction Survey on organizational culture, institutional performance, diversity, and inclusion, change management and modernization initiatives	ICRISAT workforce	A comprehensive staff feedback which will form the basis for continuous improvement plans for Human Capital Management	
Output 2:	*Diversity and inclusion*			
2021	Modernize the Institute's Diversity and Inclusion approach through a global strategy.	ICRISAT workforce and stakeholders	A detailed action plan impacting the major aspects of people processes and practices	Enhancing the overall work experience through a culture of engagement, wellness, diversity and inclusion that leads to employee well-being, productivity and retention
2022	Implement the Diversity and Inclusion strategy and action plan	ICRISAT workforce and stakeholders	An evolving culture focusing on equity, fairness and shared learning in a way that best leverages the Institute's capabilities	
2023	Disseminate knowledge tools and conduct leadership training	ICRISAT workforce and stakeholders	A strengthened diversity and inclusion approach supported by a trained workforce and matured leadership	

iv) Talent acquisition

ICRISAT must attract and retain high quality talent in the most efficient, effective, fair and transparent manner possible. Talent acquisition is a critical driver to acquire relevant skills from the external market. A talent acquisition strategy is being developed to use contemporary techniques to streamline the hiring process, while upholding the guiding principles of Equal Opportunity, Transparency, Diversity, Confidentiality and Compliance.

The talent acquisition process will be defined and detailed in a Standard Operating Procedure which will be formalized in 2021. The operating procedures will be implemented through an upgraded recruitment tool that will be launched simultaneously. The tool will completely digitize the recruitment process from requisition approval to staff onboarding, leading to reduced turnaround time, administrative compliance and better talent management. The advancement will continue in 2022 through customized training on modern recruitment techniques for hiring managers and HR staff members, leading to enhanced quality of hire and candidate experience. Strengthening the internal talent acquisition strategy will enable an institutionalized Employee Value Proposition that will aim to optimize external branding and communication initiatives, and project ICRISAT as an employer of choice. This will result in access to a wider and richer candidate pool and reduced hiring costs. The Employee Value Proposition will be formulated and delivered in 2023.

Logical Framework of talent acquisition: Major outputs, intended users, outcomes, and impacts

Talent acquisition				
	Output Targets	Intended users	Outcomes	Impacts
Output 1:	Streamlining the talent acquisition process			
2021	Defined recruitment principles and complete digitization of recruitment and on-boarding operations	ICRISAT workforce and candidates	Robust hiring process and practices, increased efficiency, administrative compliance and reduced turn-around time for recruitment operations	On-time recruitment of the right talent for each job, while upholding the principles of Equal Opportunity, Transparency, Diversity, Confidentiality and Compliance
2022	Customized training and certification on hiring and interviewing techniques	Hiring Managers and HR staff	Enhanced quality of hire and candidate experience	
2023	An institutionalized Employee Value Proposition to optimize branding and communication initiatives, and project ICRISAT as an employer of choice	ICRISAT workforce and candidates	A visible employer brand enabling access to a diverse and richer candidate pool	

Legal Office

1. Introduction

The legal office plays a critical role in supporting the work of various institutional units and processes in a highly dynamic operational environment at the global level. It extends legal support to the institute's multi-faceted governance structure, research and operation units, legislative advocacy and applicable statutory compliances at all locations. It provides legal risk analyses, proposes effective mitigation strategies and supports the institute in all legal matters. It also helps develop effective and efficient structures for projects, and negotiates and drafts all agreements for the institute, including agreements with donors, partners, vendors and consultants. The legal office at headquarters advises the leadership and management on matters concerning operations, employment, intellectual property rights, public relations, conflicts of interest, privileges and immunities, policies, governance and compliance with relevant laws and regulations at headquarters and locations in Africa.

As a support function, it extends support to the institute's governance framework, litigations, international administrative law, human resources, finance and operations, grants and contracts, intellectual property, research, and Governing Board related documentation. It also plays an integral role in dispute resolution, mediation and avoiding unproductive litigation.

To achieve the objectives of the research and Strategic Plan under the MTP, legal issues need to be managed professionally so that the institute's activities can be carried out efficiently and effectively. Legal support is also required to ensure that research and operations are being carried out in compliance with relevant laws, in accordance with internal policies and procedures and consistent with international norms.

2. Highlights of the plan

During 2021, the legal office will identify potential disputes and litigation, and review existing practices in resolution and legal risk mitigation strategies at headquarters. Efforts will be made to reduce the number of existing unproductive litigations at HQ. Additionally, the usual legal support in matters related to policies, host country relations, taxation, contracts and donor relations, IPRs, etc., will be continued.

Logical framework of Legal Office: Major outputs, intended users, outcomes, and impacts

	Output Targets	Intended users	Outcomes	Impacts
Output 1:	Efficient and responsive legal services			
2021	Potential disputes and litigation issues identified, and existing practices for resolution and legal risk mitigation strategies reviewed at HQ level Reduced number of unproductive litigations at HQ Existing policies reviewed and new policies drafted and evaluated from a legal perspective Analysis of IP portfolio completed	Institutes' management, Governing Board Various research and non-research units at HQ, including Research programs, Finance, Operations, Human Resources Country and regional offices	Review and analysis report on legal issues including pending and historical matters related to tax, labour, contract, IPRs New and updated/ revised policies IP categorized and records updated	Increased efficiency and productivity of research and non-research units Reduced disputes and litigations Updated policies and standards Efficient IPR management and enhanced IPR skills Easy and consistent access of specialized legal advisory and services to institutes' management Better management of available resources Savings through reduced dependency on external support Effective implementation of institute's mandate and mission
2022	Consolidation of Legal Service functions at a single place, including subjects related to tax, labour, contract, IPR, host country relations Potential disputes and litigation issues identified, and existing practices for resolution and legal risk mitigation strategies reviewed at Country and regional office levels Efforts to reduce number of existing unproductive litigations at locations IP culture promoted through quarterly training and skill development activities	Institutes' management, Governing Board Country and regional offices	Report and strategy on integration of legal functions and a robust model to manage legal issues centrally in place Review and analysis report on legal issues at various locations in Country and regional offices Flexible use of available legal resources across geography and locations IP training modules and programs	
2023	Strengthen the Legal Office with effective in-house functions with reduced dependency on external legal support	Institutes' management, Governing Board Scientists	Strategy on strengthening in-house legal functions and more focussed	

	Research on existing host country, partner, and/or donor relations and new strategies proposed to improve the institute's brand image from legal and compliance perspectives Emphasis on the use of ICT solutions in delivering legal services IP protection, renewal and technology transfer activities at regular intervals	Various research and non-research units Country and regional offices, and project setup	use of legal skills and capabilities Review and analysis report on enhanced legal compliance Adoption of new technological tools in record keeping, legal issue management and service delivery Strategies and model for IP protection and commercialization	

Smart Food

Overview and Rationale

1. Introduction

As highlighted in the Strategic Plan, Smart Food is an established and well-articulated way to communicate the importance and value of ICRISAT's mandate crops, categorizing their main attributes into three key areas of being good for you, good for the planet and good for the farmer. 'Good for you' refers to the nutritional and health qualities. 'Good for the planet' refers to the environmental impact and sustainability, e.g. the contribution of nitrogen in the soil, low need for water, less fertilizer and pesticide use and lower carbon footprint. Good for the farmer includes e.g. the survival in high temperatures and more marginalized land, higher resilience and ability to cope with climate change, as well as the multiple uses and potential to increase yields and untapped markets. Together these characteristics make these dryland crops highly important during a climate crisis, worsening hidden hunger and as an option for the most marginalized farmers.

The campaign around promoting our crops as a Smart Food centers around the need to diversify on farm and diets, and especially to diversify staples that can typically constitute 70% of the plate and hence provide an opportunity to make a big impact.

ICRISAT's Strategic Plan recognizes Smart Food as an informative byline and a platform for the nutrition inherent in our crops to be understood, and to ensure that thought leaders in Africa and Asia lead their communities to adopt these foods both in a cultural context and to ensure good nutrition.

Describing ICRISAT's mandate crops as smart foods – good for you, the planet and the farmer is an easy descriptor to understand their overall value and draw attention to these crops. It is an important communications tool and branding to promote the value and need for these crops. The term has also become internationally recognized and closely associated with ICRISAT's mandate crops. Leveraging this will be important and advantageous to ICRISAT.

2. Highlights of the plans

The Smart Food byline will be leveraged to achieve a key output that the value of ICRISAT's mandate crops is globally recognized, especially across Africa and Asia. This will require recognition by donors globally, collaborators (from researchers to private industry), governments across Asia and Africa, industry (from seed producers to food processors) and media.

An overall target to achieve this is the wide promotion of science-backed information on the crops. This will be designed around the categorization of – good for you, the planet and the farmer. Communications messaging and material will be developed, but will more importantly need scientific backing. Not all the scientific backing was easily available and agreed on. Collation and analysis were needed to further develop the messaging.

The use of the Smart Food byline should be integrated into both communications and scientific outputs, using it to describe ICRISAT's mandate crops wherever practical. This will be important for further enhancing global

recognition, so that ICRISAT's crops are commonly recognized as and referred to as smart foods, helping them stand out as important.

The impact that can accrue from such a move is more policy support, programs developed for ICRISAT's mandate crops and funding to support research for development.

The specific output will be that the value of ICRISAT mandate crops is recognized. In 2021, the key activities will be the finalization and wide promotion of the 'good for you' case for millets and sorghum. The major nutritional and health benefits of millets and sorghum have been collated and analysed through systematic reviews. This was led by ICRISAT's nutritionist with other specialists within ICRISAT and organizations across many countries. These are the largest systematic reviews undertaken on millets and sorghum and are expected to garner major attention in regard to the important contributions they can make to priority nutrition and health needs. They also target some of the biggest needs of children and women.

A major promotional campaign will be undertaken on these study results to maximize the attention to the crops and ICRISAT's work. The importance of these crops will be promoted to donors and governments to garner future support for them in funding and support programs. Promotional activities will be undertaken jointly with other collaborators of the study to leverage as many networks as possible.

Complementing the major promotion on how millets and sorghum are 'good for you' will be a second output promoting the full case of how millets and sorghum are good for you, but also how they are good for the planet and the farmer. Together this more holistically supports the need for millets and sorghum and the focused efforts to bring them back as staples across Africa and Asia.

The data and key messaging collated on how ICRISAT's mandate crops are good for you, the planet and the farmer should be fed into ICRISAT's external communications activities to draw attention to the crops and the need for investments. This will be a key input to during ICRISAT's 50th Anniversary and the International Year of Millets. This will target donors, collaborators, governments, industry, consumers and media. The aim is to have wide coverage on this and use all communication channels. Complementary to this will be integrating it into scientific channels through presentations and documents or articles. Partners with similar views on the value of millets and sorghum and the need to diversify staples will be engaged to widen the network and messages. There are numerous topical fora that Smart Food messaging complements, e.g., the movement to popularize neglected and underutilized foods, fora on biodiversity, the recently launched UN Decade on Ecosystem Restoration as well as the UN Decade on Nutrition.

The impact aimed to achieve is the increased production and consumption of millets and sorghum across the drylands of Asia and Africa. More funding for ICRISAT's work will be key to achieving this. A whole value chain approach is needed from breeding, seed systems, on farm support to agribusiness, product development and market linkages and promotions. Promoting the value of millets and sorghum with scientifically-backed messages are central to achieving this.

Logical Framework of Smart Food: Major outputs, intended users, outcomes and impacts

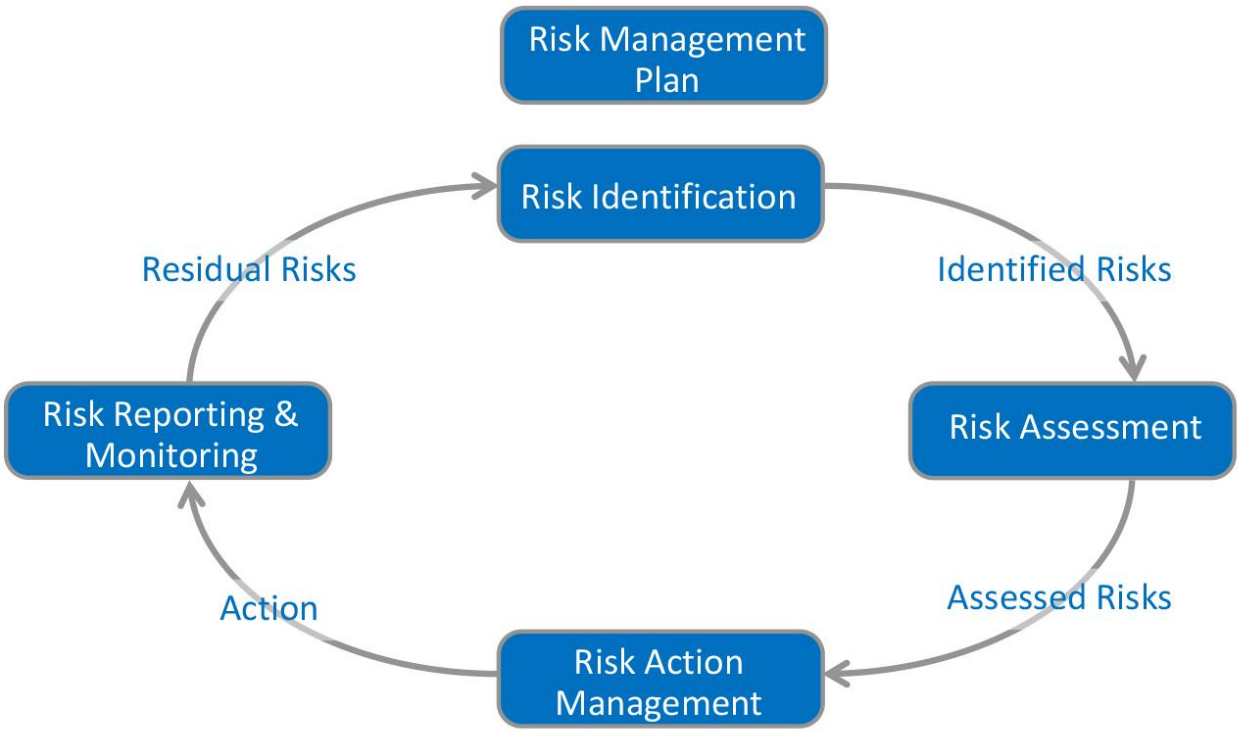
	Output Targets	Intended users	Outcomes	Impacts
Smart Food: The value of ICRISAT mandate crops recognized	Science-backed information on the crops widely promoted	Donors, collaborators, governments, industry and media	Media coverage, digital media reach, activities reach	More policy support, programs and funding for the crops
Output 1:	The value of ICRISAT mandate crops recognized			
2021	Finalization and wide promotion of the 'good for you' case for millets and sorghum	Donors, collaborators, governments, industry and media	Media coverage, digital media reach, activities reach	More policy support, programs and funding for the crops
2022	Finalization and wide promotion of the full good for you, the planet and the farmer case for all mandate crops	Donors, collaborators, governments, industry and media	Media coverage, digital media reach, activities reach	

2023	Campaign to leverage the International Year of Millets	Donors, collaborators, governments, industry and media	Media coverage, digital media reach, activities reach	
Outputs	Output Target	Intended user	Outcome	Impact
Staples are diversified with millets and sorghum	Smart Food campaign to diversify staples	Donors, collaborators, governments, industry, consumers, media	Wide coverage on the topic Partnerships to achieve this built	Increased production and consumption of millets and sorghum across the drylands in Asia and Africa
Output 2	ICRISAT scientific knowledge available and accessible			
2021	Case for millets and sorghum as 'good for you, the planet and the farmer' further developed and promoted	collaborators, governments, industry, consumers, media	Wide coverage on the topic Partnerships to achieve this built	Increased production and consumption of millets and sorghum across the drylands in Asia and Africa
2022	Wide outreach campaign, both broad and targeted	collaborators, governments, industry, consumers, media	Wide coverage on the topic Partnerships to achieve this built	
2023	Campaign to diversify staples leveraging the International Year of Millets	collaborators, governments, industry, consumers, media	Wide coverage on the topic Partnerships to achieve this built	

Risk Management

The Risk Management activity as part of the MTP will include a regular assessment of activities against the Risk Register. This involves series of steps as detailed in the figure.

To be able to manage its risks effectively, ICRISAT is currently looking for leaders who will own the function of Risk Management end-to-end. This will entail having a Risk Management Plan in place focused on risk identification, risk assessment (along with the action plan to mitigate these risks) and reporting to the Governing Board with the necessary updates.

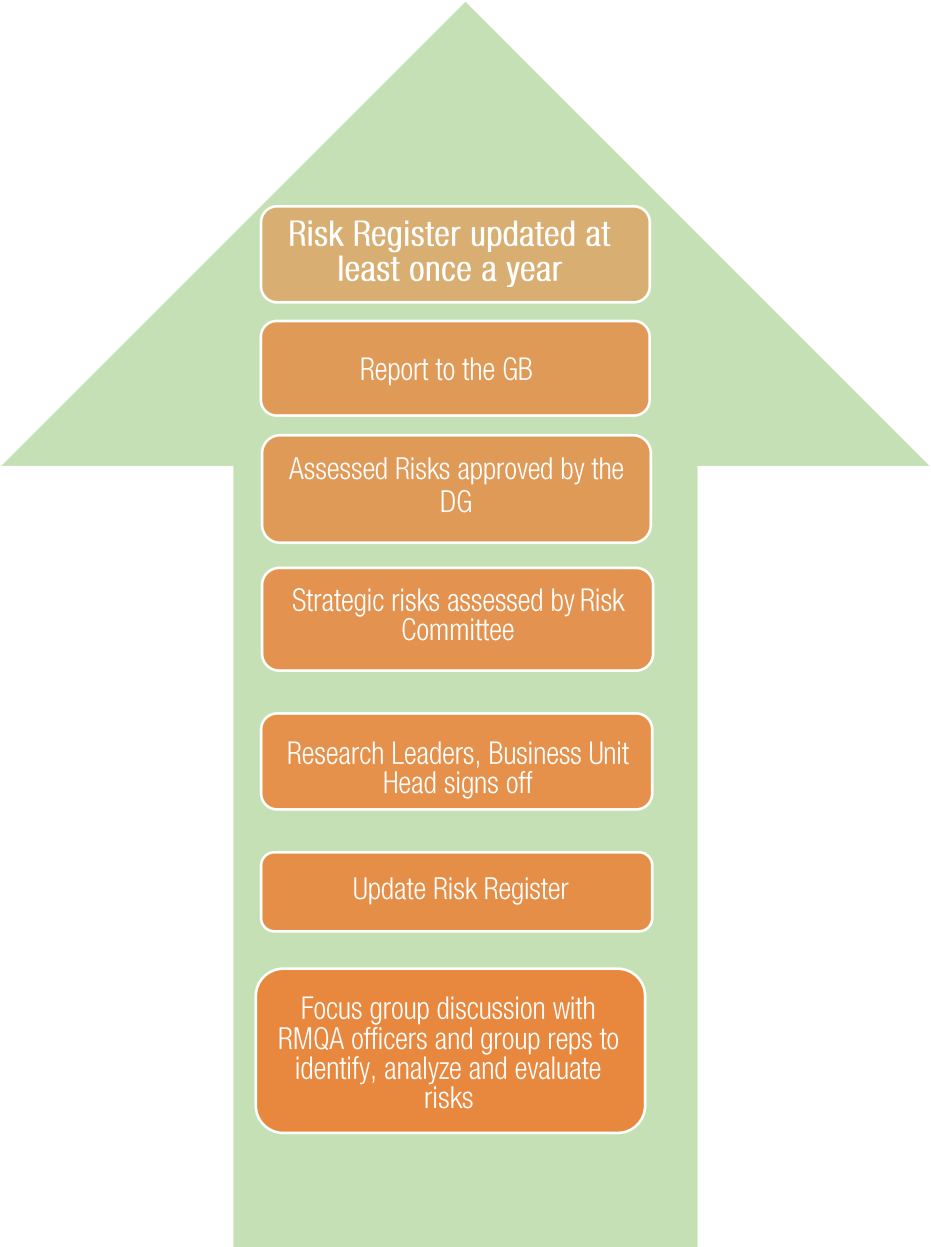


A Risk Management Team is being put in place to focus on the following key initiatives:

- Setting up the risk identification process and structure of the Risk Management Committee
- Revisit the existing Risk Register and work with senior management to rebuild it from scratch. This is seen as valuable (particularly for new leaders who joined ICRISAT from outside), and not because the current register has major problems.
- Rebuild the Environment Health and Safety (EHS) structures and processes. The refresh will help bring issues to the forefront and create personal "ownership" of ICRISAT's approach to EHS and modern best practices.
- The team will also cover the Business Continuity Plan (BCP) and Disaster Recovery Plan (DRP) within its scope of operations.

The risk capturing process is envisaged to be as depicted as shown in figure

A bottom-up approach to capturing risks will enhance connectivity between headquarters and country offfices, recognizing that a globally distributed organization requires clear and consistent processes and systems that operate globally in order to efficiently manage the organization.



Highlights of the plan

Logical Framework for Risk management (and Business Continuity Planning)

	Output targets	Intended users	Outcomes	Impacts
	Risk management function set-up			
2021	Recruit Risk Management Manager Set up a Risk Management team Set up the risk management structure to capture risks worldwide Communicate to various stakeholders on the new risk management structure Set up the risk capturing process – bottom-up approach Set up the Risk Evaluation Committee consisting of the Risk Manager, Director General (Chair), Director Institutional Finance & Services, Deputy Director General- Research, Acting Director- HR, Regional Directors of ESA & WCA	ICRISAT research and global teams	Setting up this critical team will help in controlling risks This will also take care of BCP and DRP	Will impact research and non-research teams globally
2022		ICRISAT workforce	Will ensure business continuity in times of crisis This will help ICRISAT mitigate its risks	Will impact research and non-research teams globally
2023	Obtain feedback and improve the risk register Sort out any issues in implementing BCP and DRP	ICRISAT workforce	Will ensure Business continuity in times of crisis This will help ICRISAT to mitigate its risks	Will impact research and non-research teams globally

Finance

Background

ICRISAT's Finance team operates on an ERP system which is the Sun System. It operates on cost-based accounting principles adopted by the CGIAR under the "CGIAR Cost Allocation Guidelines: Financial Guideline No. 5" and conforms to IFRS accounting standards. The ERP in its current form does not support our current business demands on automation. Consequently, ICRISAT is now looking at upgrading the Sun System modules to enable digitization for better control, digitized reporting, standardization and strengthening internal controls.

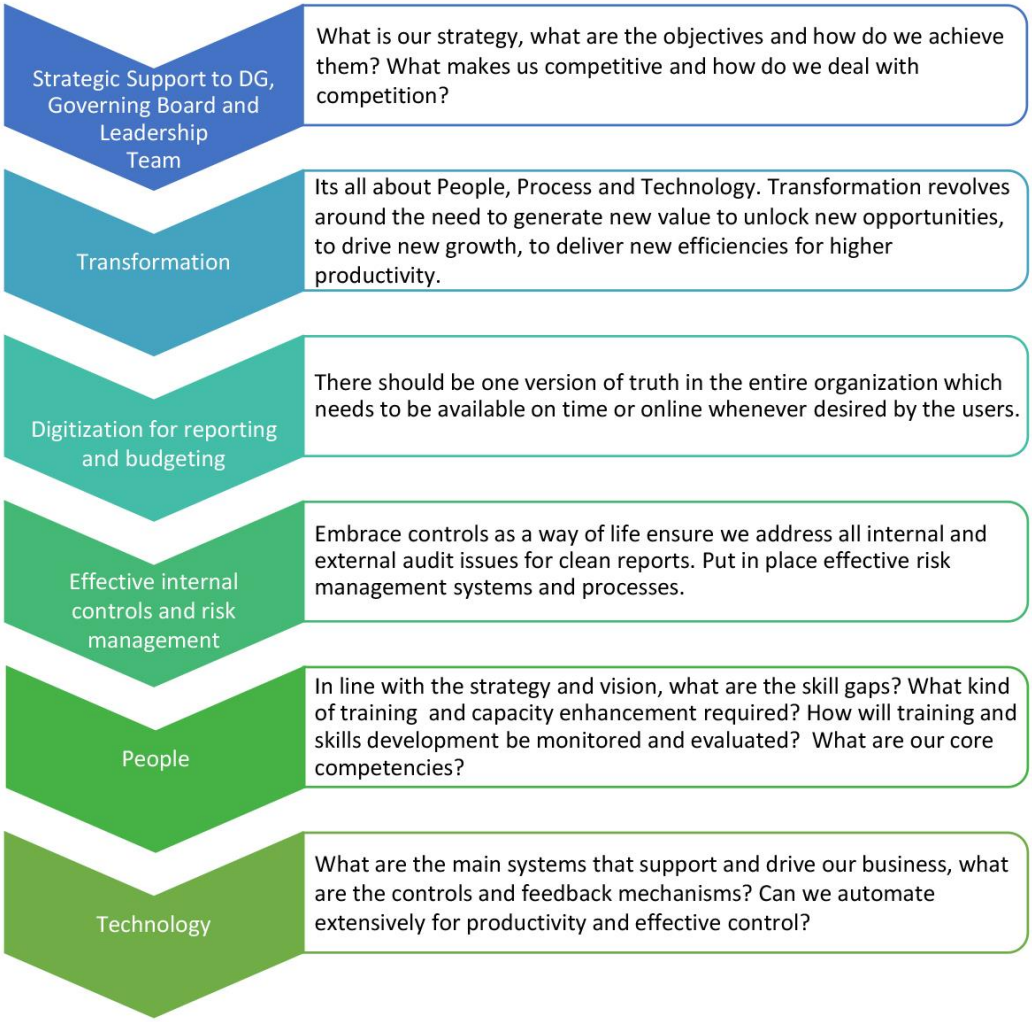
In the current competitive environment, management requires more frequent and more incisive financial reports in order to manage a complex enterprise in challenging financial times. ICRISAT must have the capacity to leverage its

existing resources for better control, transparency and timely reporting. This will enable ICRISAT to better leverage the resources available at its disposal to meet its financial goals.

Finance's vision

Top performing businesses have top performing finance functions, but few finance functions are top performing unless they are aligned to the business needs and operate with a customer focus with speed and accuracy through automation, as shown in the figure

The high-level finance vision is shown below



Context for these proposals and their scope

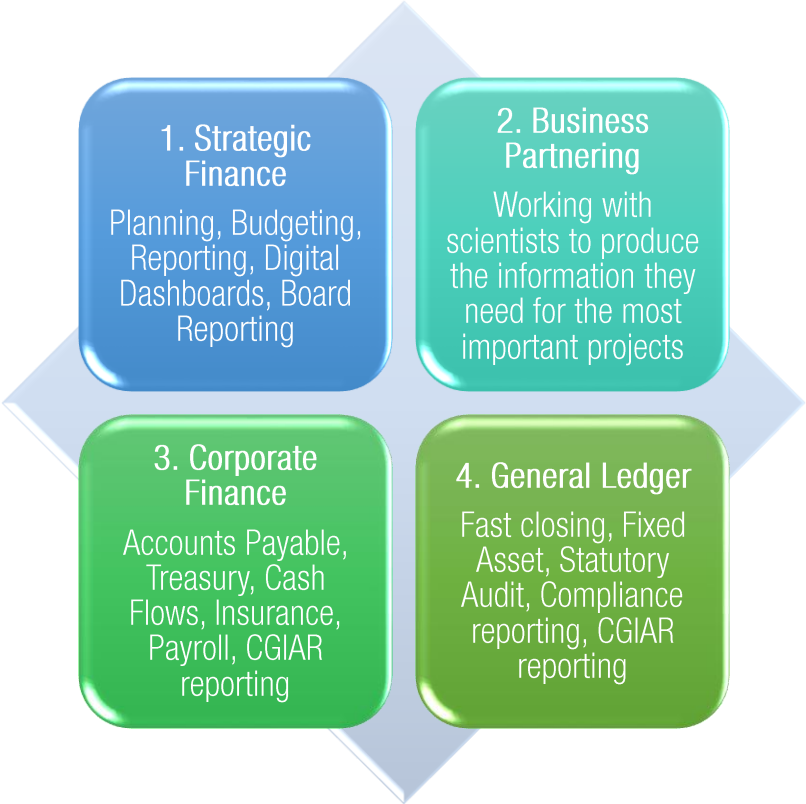
Keeping the above expectations in mind, the finance team plans to concentrate focus on driving "intelligent" finance by:

a. Strengthening their strategic alignment, business planning, performance reporting and analytical capabilities
b. Consistently transforming data into intelligence that enables actionable decisions based on insightful reports that highlight key performance measures
c. Digitizing and automating to the extent possible under the current resource constraints
d. Standardizing and streamlining the finance processes across various regions
e. Restructuring the Finance organization to meet ICRISAT's overall business strategy and operational goals

f. Focused approach in achieving the Governing Board approved budgets by working jointly with the Research teams to target a surplus results
g. Have a strong emphasis on reducing the overall costs and reshaping the finance function
h. Leveraging technology to reduce the manual intervention which goes on to enhance the internal control process
i. And finally, to generate reports which will help the stakeholders take appropriate and timely decisions through automation of the reporting function.

This can happen by driving a transformation which will cover People, Processes and Technology. The People aspect will be addressed by reorganizing the finance team into four centres of excellence as depicted below:

Centres of Excellence



The Process and Technology areas will be taken care of by driving process re-engineering and driving automation. The Logical framework for the above is captured at a high level in the table below:

Logical Framework for Finance: Major outputs, intended users, outcomes, and impacts

	Output targets	Intended users	Outcomes	Impacts
Output 1:	Business partnering			
2021	Reorganize the finance team to create Center of Excellences (COEs) Align the Business finance team members to the Research teams for better control and partnering with the research leaders on their projects Recruit the HOF as a backfill	ICRISAT Research & Global teams	The reorganization will ensure focused approach to address issues by assigning responsibilities to concerned individuals with the desired expertise. Reorganization will bring in better control as CO's will also get covered bringing in transparency,	Will impact the research and non-research teams globally

	Recruit 2 manager finance roles one of which are backfills Re-organize the functional reporting lines for Finance and services for Africa Recruit Regional Head of Finance for Africa regions for better control and over sight of Africa operation to mitigate risks and strengthen controls Explore the options of getting the GST (Good & Services Tax) law amended to have ICRISAT exempted. Plan for addressing the legacy issue relating to the Wheeling charges levied on ICRISAT by the Electricity Board Start a dialogue with the Sewerage department to reverse the sewerage cess imposed on ICRISAT Explore options of Section 35 business that Research is wanting to explore		better internal controls, economies of scale and address some SOD issues (Segregation of duties issues) raised by the auditors This will also drive better internal control and alignment with functional goals for the organization as a whole Backfilling some positions will enable brining in fresh talent with new ideas and experiences to look at things afresh for improvements New positions will bring in better control and monitoring operations which will ultimately lead to productivity, process efficiency, better control and add value to the bottom line by identifying sources of waste existing in the system Once we sort out the GST issue we can explore options of other channels of revenue Sorting these issues will help to protect the Institutes cash flow/costs and also not having to make any provisions which will be a hit to our bottom line	
2022	Take customer feedback and improve interaction and service to customer Explore options of giving projects reports / explaining the project digital dashboards to the Research leaders/teams Drive ontime raising of customer invoices Follow-up for prompt collection of customer invoices	ICRISAT Workforce		

	Explore opportunities of upgrading the sun system removing manual touchpoints to the extent possible and laying down the path for bringing in digital dashboards			
2023	Internal Review to evaluate the efficacy of the new structure and policies, automation initiatives and measure deviation from the objective.	ICRISAT Workforce	Document the success and areas of improvement.	
Output 2:	Sun System upgrade and automation			
2021	Design and Implement Host to Host Payment mode thereby enabling payments without manual intervention as per external audit recommendation Leverage the Sun System	ICRISAT Finance and other stakeholders	Exploit the technological capabilities of the system to enable better control and reporting Upgrading the Sun System will help in automation and having a digitized work environment in ICRISAT Facilitate better control, prompt reporting and opportunities of driving productivity benefits across the functions	High performance delivery towards achieving ICRISAT's mandate, mission, and vision. Driving cultural change in the way we operate the commercials of our projects
2022	Implement the Sun System upgrades Redesign the Reporting process Implement the digital dashboards and encourage its usage Supplement Sun system with off-the-shelve software for easy of customization and costs.	ICRISAT Finance and other stakeholders	Moving away from a manual driven excel based state of operations to a digital environment	Moving ICRISAT to the next level in terms of reporting
2023	Improve on Digital Dashboards based on feedback received	ICRISAT Workforce	Online reporting facility	
Output 3:	Process re-engineering with help from Quality (Six Sigma)			
2021	Recruit a Process Transformation/ re-engineering leader Re-engineer the processes across (HQ & COs) to bring in efficiency, standardization & productivity by doing away with non-value added work	ICRISAT Workforce	This will drive simplification, standardization, efficiency and control Manage the project spends effectively to help ICRISAT reduce project carry forwards and increase recovery of overheads leading to a positive bottom line	Will impact the research and non-research teams globally

	Get all the process maps prepared from a control standpoint Work on implementing workflows for digitization Set-up the travel desk by backfilling the role and improving the current software Start monthly closing of books and reporting Implement digital signatures to cutdown on manual transfer of files and papers and efficiency Bringing in a culture of measurement in the finance team by implementing Key Process Indicators (KPIs) Explore options on Asset Insurance (preferably a global policy covering all ICRISAT locations) to leverage scale for cost & operational benefits Also explore options of a Cyber Insurance policy Re-engineer the Asset tracking and re-possessing process Have physical verification done of our assets and Automate Asset tracking process for the future From a control standpoint start monitoring the unfunded staff costs in order to reduce ICRISATs exposure Re-engineer the process of billable accounts to make it "Center Earned Income" Start the process of SECURED revenue and UNSECURED revenue		Travel is an important function but today we do not have anyone owning this process so the positions needs to be backfilled urgently. We also need to look at the software for effectiveness, and commercials in view of customer feedbacks received Implementing measurement culture will promote a performance based culture Asset insurance is required in most project as part of the donor agreement. Also it will help mitigate the risk including Cyber risks Assets tracking tool is critical for better internal control Address the unfunded issue to reduce the continuous bleeding of scare resources to finance this "Bench" which does not bring in any revenue instead is a source of cost or cash outflow only This will help in understanding our revenue mix and risks better	
2022	Evaluate the current Travel Application or Traform from user's perspective and its commercials. Take feedback from stakeholders across locations/regions	ICRISAT Workforce	This will bring in a culture of performance measurement	

	Discuss and look at options in the market that meets our global needs Enhancing the overall work experience through a culture of productivity and efficient service. This will help in driving a KPI culture			
2023	Increase stakeholder satisfaction through delivery of efficient and timely service (through measurement of KPI's) at a reduced cost	ICRISAT Workforce	A comprehensive staff feedback which will form the basis for continuous improvement plans for Human Capital Management.	
Output 4	Talent assessment and retention			
2021	Develop an internal communication framework for employee engagement and feedback. Modernize the Institute's Diversity and Inclusive approach through a global strategy leveraging cross locational talent pool available to ICRISAT as a whole. Start training the team on areas which will enhance their skillset to perform better Start training sessions – Finance for Non-Finance people.	ICRISAT Workforce	A planned and coordinated workforce relations driving transparency, sharing of thoughts, driving targets and strategic directions/goals This helps in brining in better internal controls like in banks, enhancing employee experience and job satisfaction Creating a work environment free from FEAR psychosis to encourage performance.	Enhancing the overall work experience through a culture of engagement, wellness, diversity, and inclusion, that leads to overall employee well-being, productivity, and retention. Will help in having a highly skilled and experienced team
2022/2023	An institutionalized Employee Value Proposition to assess opportunities of job rotation	ICRISAT Workforce and Candidates	*This will bring in better internal control as it happens in banks and other financial institutions*	

Institutional Services

Purpose of the function

ICRISAT's Institutional services team provides ongoing support to the research and corporate functions through provision of support services and facilities. It supports ICRISAT through the development of infrastructure and capital investment programs. Institutional Services will consist of 7 business units:

- Procurement, Supply and Disposal Services
- Transport
- Security
- Housing & Food Services
- Information Services Unit
- Risk Management
- Field Medical Unit
- Travel

Funding for the Institutional Services function is derived from indirect costs, operational support charges, and from recoveries of direct costs from grants.

Many opportunities have been identified that will potentially reduce costs and increase efficiencies within operational services globally. This process is only beginning, and continual improvement and change management is imperative. Such initiatives represent value-promoting opportunities in reducing transaction time, improving communication, and reducing costs with greater transparency.

A major part of the Institutional Services business plan is to eliminate or mitigate identified problems in current infrastructure through a prospective development of a master plan for infrastructural redevelopment subject to availability of funds. This includes, but is not limited to, corporate services, concessionaries, research support infrastructure, Visitor Experience, laboratories, research workspaces, dormitories, meeting rooms, and safety and security infrastructure.

Infrastructure projects

After nearly 49 years, ICRISAT is struggling with the prohibitive cost needed for repairs, maintenance or replacement costs, as the case maybe, of its facilities, some of which are critical items like generators and transformers. The current situation is being handled by fixing urgent areas only on a piecemeal basis. Housing, Office buildings, Cafeteria are some areas that also need urgent investments.

Procurement, Supply & Disposal Services

Logical Framework for Procurement, Supply & Disposal Services: Major outputs, intended users, outcomes, and impacts

	Output targets	Intended users	Outcomes	Impacts
Output 1:	Asset management			
2021	Automating the supply chain management process Set up tracking software and hardware Have a centralized purchasing function	PSDS Research and non-research teams globally	Better control, tracking of orders and assets, capitalization in our financial books, physical verification and control. Eliminate manual touchpoints and the probability of error. Better negotiation power with suppliers. It will also lead to standardization, efficiency and productivity.	Will enhance productivity, enable prompt ordering, receipt of goods and subsequent asset tracking. Help the procurement process from requisition to preparing the Good Receipt Note
2022	Implement the Sun System upgrade, if available, and implement the asset tracking module	ICRISAT workforce	Better control and help in physical verification and reconciliation with the asset register	Improved tracking and management of institutional assets.
2023	Help in setting re-order levels for frequent purchases	ICRISAT workforce	Better negotiation and help in managing ageing stock	Improved stock management
Output 2:	Process changes			
2021	Update policies and procedures; review, update and revise existing policies as required	ICRISAT Finance and other stakeholders	Sync between actual process and documented processes	Help control purchases. Facilitate better control, prompt

				reporting and opportunities of driving productivity benefits across the functions
2022	Track and retrieve used assets Decide on suggested disposal options of written off/ used assets Monitor the ageing of inventory to mitigate the risks of obsolescence	ICRISAT Finance and other stakeholders	Better control over assets helps cash flow management Control on inventory write-offs as a result of obsolescence	Written off assets like laptops, printers and other such items can be given away to the community, orphanages, etc.
2023	Training the team on best practices in supply chain management.	ICRISAT workforce	Improved skills and capacity in the team	Better service to research and non-research units

The current PSDS department will be transformed into an automated unit to bring in more control and to eliminate manual intervention to the extent possible. This will mean using tools like the asset tracking software available in the market which will help digitize this process end-to-end and also assist in the physical verification of assets. Digitization will standardize processes across all ICRISAT locations and lead to productivity, efficiency, reduction in cost and turnaround time.

Housing & Food Services

Logical Framework for Housing & Food Services: Major outputs, intended users, outcomes, and impacts

	Output targets	Intended users	Outcomes	Impacts
Output 1	Workflows			
2021	Implementing workflows for efficient tracking of service requests Completing the kitchen renovation as per approval received but which was put on hold due to COVID-9	ICRISAT research and global teams	The automation will go a long way in servicing customer requests	Will impact research and non-research teams globally
2022	Supplement the above with mobile facility option Sending high performing staff on hospitality trainings Upgrading and installation of solar water heaters	ICRISAT workforce	Enable user- friendly applications Enhancing employee morale and efficiency Foster a performance-driven culture Reducing electricity costs	
2023	Obtain feedback and improve, if feasible and cost effective	ICRISAT workforce		

Information Services

Logical framework for Information Services Unit: Major outputs, intended users, outcomes, and impacts

	Output targets	Intended users	Outcomes	Impacts
Output 1:	Workflows			
2021	Recruit an ISU leader and evaluate the capacity of the ISU team Evaluate options available to ICRISAT for its domain Evaluate options for using the Cloud	ICRISAT research and global teams	Setting up this critical team will be very important It will also go a long way in protecting ICRISAT's IT interests and infrastructure	Will impact research and non-research teams globally
2022	Evaluate server back-up processes and security Access infrastructure investments required, if any Evaluate the option of engaging in-house capability to handle simple customizations or creation of workflows to save cost on external engagements and save time	ICRISAT workforce	Will ensure business continuity in times of crisis	
2023	Mitigation of Cyber security risks through secure firewalls and Cyber Security Insurance	ICRISAT workforce		

The ISU function needs to be strengthened in view of the focus and importance given to automation and digitization. As a first step, a new ISU leader needs to be identified to lead this function to the next level. This will be done by structuring the function in a manner that builds internal capacity to meet some basic demands for automation through in-house resources, thereby reducing cost but not at the cost of efficiency and digitization.

Annexure 1: List of Potential Partners to be Engaged in Implementing MTP 2021-2023

A	Foundation Research Partners will be mostly Advanced Research Institutes (ARIs)	
1	Crop Breeding	1. Department of Agriculture and Fisheries, QLD 4610, Australia 2. Hualien District Agricultural Research and Extension department, Hualien, Taiwan 3. University of California (UC Davis), Davis, California 4. Flinders University, South Australia, Australia 5. University of Saskatchewan, Saskatoon, Canada 6. The University of Western Australia, Crawley, WA, Australia 7. University of Nebraska-Lincoln (UNL), USA 8. The University of Tokyo, Japan 9. CSIRO- Australia 10. Indian Institute of Technology, Hyderabad 11. Texas A & M University, Texas, USA 12. Queensland Alliance for Agriculture and Food Innovation 13. Hermitage Research Facility, Queensland, Australia 14. National Institute of Plant Genome Research, JNU campus, New Delhi, India 15. Peanut Innovation Lab of FtF, UGA, USA 16. University of Georgia, Athens, GA 30602, USA 17. ICAR-Indian Institute of Millets Research (IIMR), Hyderabad, Telangana, India 18. ICAR-Indian Institute of Pulses Research (ICAR-IIPR), Bhopal, Madhya Pradesh 19. Indian Agricultural Research Institute (IARI), Pusa, New Delhi 20. Punjab Agricultural University (PAU), Ludhiana, Punjab 21. Estacion Experimental Agroindustrial Obispo Colombres, Las Talitas/ Tucumán, Argentina 22. Facultad de Cinencias Agropecuarin, Universidad Nacional de Córdoba, Argentina 23. Rothamsted Research Limited, West Common, Hertfotdshire, UK 24. Spanish National Research Council, Madrid, Spain 25. Washington State University, Pullman, WA 26. Feed the Future Innovation Lab for Climate-Resilient Sorghum, University of Georgia 27. Feed the Future Innovation Lab for Crop Improvement, Cornell University 28. The land Institute, USA 29. Department of Agricultural Research Services (DARS), Malawi 30. Tanzania Agricultural Research Institute (TARI), Tanzania 31. University of Dodoma (UDOM), Tanzania 32. Sokoine University of Agriculture (SUA), Tanzania 33. World Agroforestry Center (ICRAF), Tanzania 34. International Institute of Tropical Agriculture (IITA),Tanzania 35. Zambia Agricultural Research Institute (ZARI), Zambia 36. Mozambique Institute of Agriculture Research 37. National Agriculture Research Organization (NARO), Uganda 38. Kenya Agricultural and Livestock Research Organization (KARLO), Kenya 39. University of Nairobi 40. Egerton University, Njoro, Kenya 41. Lilongwe University of Agriculture and Natural Resources (LUANAR) 42. University of Zambia 43. James Hutton Institute, UK 44. Institute of Biological, Environmental and Rural Sciences, Aberystwyth University 45. Georg-August-University, Goettingen, Germany

		46. School of Food Technology, Nutrition and Bio-Engineering 47. College of Agricultural and Environmental Sciences, Makerere University 48. Global Change Research Institute of Czech Academy of Sciences, Brno, Czech Republic 49. University of Namibia, Namibia 50. Centre for Ecology & Hydrology Environment Centre, Wales, Bangor, UK 51. ARC, South Africa 52. CIRAD (France), Montpellier Cedex 5, France 53. Université de Ouagadougou, Ouagadougou, Burkina Faso 54. IPR-IFRA, Koulikoro, Mali 55. FST- Université STTB, Mali 56. Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria 57. Lake Chad Research Institute (LCRI), Maiduguri 58. Federal University of Agriculture Makurdi, Makurdi
2	Crop Protection & Seed Health	1. North Carolina State University, USA 2. Lilongwe University of Agriculture and Natural Resources, Malawi 3. CGIAR centers: IITA, CIMMYT, CIP CIAT, ICARDA, IRRI 4. University of Georgia, Athens, USA 5. University of Zambia 6. Texas Tech University (TTU), Lubbock, Texas, USA 7. University of Strathclyde, Glasgow, Scotland 8. Wageningen University & Research, Netherlands 9. Washington State University (WSU), Pullman, Washington 10. NSF Centre for Integrated Pest Management (CIPM), North Carolina, USA 11. University of California, Davis, USA 12. University of Liège, Belgium 13. University of Mysore, Karnataka, India 14. Indian Agricultural Research Institute (IARI), New Delhi, India
3	Genomics, pre-breeding & Bioinformatics	1. Agricultural Research Council, South Africa 2. Biosciences for Africa (B4A), Kenya 3. CIRAD, France 4. Colorado State University, USA 5. Cornell University, USA 6. Corteva Agriscience, Hyderabad-Johnston, India/USA 7. Donald Danforth Plant Science Centre, USA 8. Hudson Alpha Institute, USA 9. ICAR-Indian Institute of Pulses Research (IIPR), India 10. Japan International Research Centre for Agricultural Sciences (JIRCAS), Japan 11. Kansas State University, USA 12. Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Germany 13. National Center for Genome Resources (NCGR), USA 14. NIAB, University of Cambridge, UK 15. Plant Genome Mapping Laboratory, University of Georgia, USA 16. Queensland Alliance for Agriculture and Food Innovation, Australia 17. Swammerdam Institute for Life Sciences, The Netherlands 18. Texas A & M University, Texas, USA 19. University of Georgia, Athens, USA 20. The Lan Institute, USA 21. University of California, Davis, USA 22. University of Sheffield, UK 23. University of Durham, UK 24. University of Nebraska-Lincoln, USA

		25. USDA-ARS, Crop Genetics and Breeding Research Unit, Tifton, USA 26. Fort Valley State University (FVSU), Georgia, USA 27. Crops Research Institute (CRI), Guangdong Academy of Agricultural Sciences (GAAS), Guangzhou, China 28. Oil Crops Research Institute (OCRI)-Chinese Academy of Agricultural Sciences (CAAS), Wuhan, China 29. Biotechnology Research Center, Shandong Academy of Agricultural Sciences (SAAS), Jinan, China 30. Henan Academy of Agricultural Sciences (HAAS), Zhenzhou, China 31. Institute of Oil Crops, Fujian Agriculture and Forestry University, Fuzhou, China 32. University of Southern Queensland, Australia 33. Key Laboratory of Peanut Biology and Genetic Improvement, Shandong Peanut Research Institute, Qingdao, China 34. Mississippi State University, USA 35. University of Western Australia 36. University of Vermont 37. BGI, China 38. The University of Queensland, Australia 39. University of Saskatchewan, Canada 40. Max Planck Institute for the Science of Human History, Germany
4	Cell & Molecular Biology and Trait Engineering	1. Donald Danforth Plant Science Centre, USA 2. International Research Centre for Agricultural Research (JIRCAS), Japan 3. Swammerdam Institute for Life Sciences, University of Amsterdam, The Netherlands 4. University of California, Davis, USA 5. Noble Foundation, Oklahoma, USA 6. Louisiana State University Agricultural Center, Baton Rouge, LA 7. Corteva Agriscience, USA
5	Genebank	1. National Institute of Plant Genome Research (NIPGR), New Delhi 2. University of Nebraska–Lincoln, USA 3. Madras Diabetes Research Foundation, Chennai, Tamil Nadu 4. INRAN (Niger) 5. INERA, Burkina Faso 6. SARI, Ghana 7. IER, Mali 8. NACGRAB, Nigeria 9. ITRAD, Chad 10. NARI, Zimbabwe 11. ISRA, Senegal

6	Crop Physiology and modelling	1. CIRAD- UMR AGAP, Montpellier Cedex 5, France 2. Indian Institute of Technology Bombay, India 3. CSIRO Plant Industry, Perth, Australia 4. School of Food Science and Nutrition, University of Leeds, UK 5. University of California, Davis, USA 6. Fraunhofer Development Center X-Ray Technology, Fürth, Germany 7. Université de Montpellier, France 8. The University of Queensland, Queensland Alliance for Agriculture and Food Innovation, Brisbane, Australia 9. University of Tokyo, Japan 10. University of Life Sciences Prague, Czech Republic 11. Ethiopian Institute of Agricultural Research (EIAR), Debre Zeit Research Center, Debre Zeit, Ethiopia 12. Hone Pty Ltd, Australia 13. CORTEVA Agriscience, USA 14. ICAR- Indian Institute of Millets Research, Hyderabad, Telangana, India 15. Phenospex Pvt Ltd, The Netherlands 16. Institute of Biological, Environmental and Rural Sciences (IBERS), Aberystwyth University, UK 17. Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran 18. International Center for Tropical Agriculture (CIAT) Cali, Colombia 19. Grain Legume Genetics and Physiology Research, USDA-ARS, and, Washington State University, Pullman, USA 20. University of Vermont, and Gund Institute for the Environment, Burlington, USA 21. Institute of Biological, Environmental and Rural Sciences (IBERS), Aberystwyth University, UK
7	Seed Systems	1. Seed Systems Unit (SSU), Department of Agricultural Research Services (DARS), Malawi 2. Agricultural Seed Agency (ASA), Tanzania 3. Tanzania Official Seed Certification Institute (TOSCI) 4. Zambia Agricultural Research Institute (ZARI), Zambia 5. Seed Control and Certification Institute (SCCI), Zambia 6. Mozambique Institute of Agriculture Research (IIAM) 7. Kenya Plant Health Inspectorate Service (KEPHIS) 8. National Agricultural Seed Council Abuja, Nigeria 9. Institut de l'Environnement et de Recherches Agricoles (INERA), Burkina Faso 10. EIAR, Ethiopia 11. CSIR-Savanna Agricultural Research Institute-SARI, Ghana 12. l'Institut d'Economie Rurale (IER), Mali 13. Institute of Agricultural Research (IAR), Ahmadu Bello University (ABU), Nigeria 14. Lake Chad Research Institute (LCRI), Maiduguri 15. Tanzania Agricultural Research Institute (TARI), Tanzania 16. Federal University of Agriculture (FUAM), Makurdi 17. National Agricultural Research Organization (NARO), Uganda 18. Kenya Agricultural and Livestock Research Organisation (KALRO), Kenya 19. Syngenta Foundation for Sustainable Agriculture, Kano, Nigeria 20. CGIAR centers: CIAT, IITA, etc. 21. Tanzania Seed Traders Association, Tanzania
8	Landscapes, Soil fertility and Water management	1. Wageningen University and Research (WUR), Netherlands 2. Bahir Dar University (BDU) 3. Wollo University 4. Addis Ababa University

		5. Water and Land Resource Center-AAU
9	Climate adaptation and mitigation	1. Indian Institute of Tropical Meteorology (IITM), Pune, through the Ministry of Earth Sciences, Govt. of India 2. Indian Meteorological Department (IMD) 3. Acharya NG Ranga Agricultural University (ANGRAU), Guntur, Andhra Pradesh, India 4. International Research Institute (IRI) for Climate and Society, The Earth Institute, Columbia University 5. University of Ghana 6. University of Florida, Gainesville, USA 7. ZALF - Leibniz Centre for Agricultural Landscape Research 8. African Institute for Mathematical Sciences (AIMS) 9. University of Reading, UK 10. University of Gottingen, Germany
10	Geospatial and Big data Sciences	1. United States Geological Survey (USGS), USA 2. National Aeronautics and Space Administration (NASA), USA 3. Asian Development Bank (ADB), The Philippines 4. North Carolina State University, USA 5. Wageningen University & Research (WUR), Netherlands
11	Digital Agriculture	1. University of Strathclyde, Glasgow, Scotland 2. CGIAR centers: CIAT, IITA, ILRI & IFPRI Microsoft 3. Indian Meteorological Department (IMD), Govt. of India 4. Food and Agriculture Organization (FAO), Italy
12	ICRISAT Development Center	1. Indian Institute of Technology Kharagpur, India
13	Agribusiness Innovation Platform	1. Department of Consumer and Food Sciences, University of Pretoria, South Africa 2. Research Institute of Sweden (RISE), Sweden 3. Industrial Training Institute, Ministry of Technology, Sri Lanka 4. Central Food Technology Research Institute (CFTRI), India
14	Gender and Youth	1. University of Reading, UK 2. University of East Anglia, UK
15	Technology Adoption and Impact Analysis	1. Wageningen University and Research, Netherlands 2. University of Bonn, Germany 3. University of Göttingen, Germany 4. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia 5. The Standing Panel on Impact Assessment (SPIA), CGIAR 6. Michigan State University, USA 7. University of California, Berkeley, USA 8. ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi, India 9. J-PAL, Asia 10. Centre for Economics and Social Studies (CESS), Hyderabad 11. Swedish Agricultural University, Sweden 12. University of Florida, USA 13. University of Western Australia, Perth 14. Oregon State University, USA 15. Columbia University, USA 16. NASA Goddard Institute for Space Studies

16	Markets, Institutions and Policy	1. Wageningen University & Research, Wageningen 2. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia 3. Massachusetts Institute of Technology (MIT), Boston, USA 4. Michigan State University, East Lansing, USA 5. Tufts University, Medford, USA 6. Arizona State University, USA 7. CGIAR centers: ILRI, Alliance of Bioversity International and CIAT, ICARDA, IWMI 8. University of Cambridge, UK 9. University of Adelaide, Adelaide, Australia
17	Nutrition, Dietary behaviour and Smart Food	1. University of Natural Resources and Life Sciences, Vienna 2. University of Reading, UK 3. Swedish Land University (SLU), Sweden 4. Ramaiah University of Applied Science, Bangalore, India 5. Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu, India 6. Kobe University, Japan 7. Ghent University, Belgium 8. Lilongwe University of Agriculture and Natural Resources, Lilongwe, Malawi 9. Sokoine University of Agriculture, Morogoro, Tanzania 10. Bahir Dar University, Ethiopia 11. University of Cambridge, UK 12. MRC, Gambia
18	Knowledge and Capacity Development	1. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia 2. University of Marburg 3. University of Natural Resources and Life Sciences, Vienna 4. IFPRI 5. ICRAF
B	**Translational Research - Partners will be institutes translating basic knowledge to translational research**	
1	Crop Breeding	1. Birsa Agricultural University (BAU), Ranchi, Jharkhand 2. Panjab Agricultural University, Ludhiana, Panjab, India 3. Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur, Madhya Pradesh 4. University of Agricultural Sciences, Bangalore, Karnataka, India 5. Orissa University of Agriculture & Technology, Bhubaneshwar, Odisha, India 6. Acharya NG Ranga Agricultural University, Andhra Pradesh, India 7. Institute of Environment and Agriculture Research, Ouagadougou, Burkina Faso 8. Department of Agricultural Research (DAR), Yezin, Nay Pyi Taw, Myanmar 9. International Center for Biosaline Agriculture (ICBA), Dubai 10. Adriana Agricola Ltda, Brazil 11. Bayer BioScience Pvt Ltd 12. Arya Hybrid Seeds Ltd 13. Bioseed Research India 14. Dinkar Seeds 15. Eco Agriseeds Pvt Ltd 16. Ganga Kaveri Seeds Pvt Limited 17. Hi-Yield Agri-Genetics Private Limited 18. Hytech Seed India Private Limited 19. JK Agri Genetics Limited 20. Kamadgiri Crop Science Private Limited 21. Kanchan Ganga Seed Co Pvt Ltd 22. Kartik Bio Seeds 23. Kaveri Seed Company Ltd

		24. Limagrain India Private Limited 25. Mahyco Private Limited 26. Nandi Seeds Private Limited 27. Nath Biogene (I) Limited 28. Nu Genes Private Limited 29. Nuziveedu Seeds Pvt Limited 30. Pioneer Hi-Bred Private Ltd (Corteva) 31. Rallis India Limited 32. Rasi Seeds (P) Ltd 33. Seeds Works International Pvt Ltd 34. Super Seeds (P) Ltd 35. UPL Limited 36. VNR Seeds 37. ICAR-Indian Institute of Millet Research, Hyderabad 38. Junagadh Agricultural University (JAU), Jamnagar, Gujarat, India 39. CCS Haryana Agricultural University, Hisar, Haryana, India 40. ICAR- Central Arid Zone Research Institute (CAZRI), Jodhpur, India 41. Sri Karan Narendra Agriculture University (SKNAU), Durgapura 42. Swami Keshwanand Rajasthan Agriculture University (SKRAU), Bikaner, Rajasthan, India 43. ICAR-Indian Grassland and Fodder Research Institute (IGFRI), Jhansi 44. Indian Agricultural Research Institute, New Delhi 45. Dr Punjabrao Deshmukh Krishi Vishwa Vidyalaya (PDKV), Akola, Maharashtra, India 46. Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Maharashtra, India 47. Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, Maharashtra, India 48. Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India 49. University of Agricultural Sciences, Dharwad, Karnataka, India 50. Indian Institute of Technology, Hyderabad 51. Professor Jayashankar Telangana State Agricultural University, Hyderabad, India 52. Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Gwalior, India 53. G B Pant University of Agriculture & Technology, Pantnagar, India 54. Vishwas Agri Seeds Pvt Ltd, Rajkot, Gujarat, India 55. Bombay Super Hybrid Seeds Pvt Ltd, Rajkot, Gujarat, India 56. Bangladesh Agricultural Research Institute (BARI), Bangladesh 57. PRAN Agro business Ltd., PRAN-RFL Group, Dhaka, Bangladesh 58. Christy Friedgram Industries (CFI), Namakkat districti, Tamil Nadu 59. Mars Wrigley, India 60. Maize and Cash Crop Research Center, Vientiane Province, Lao PDR (People's Democratic Republic) 61. Field Crop Research & Development Institute, Mahailuppallama, Sri Lanka 62. Hue University, Thua Thien Hue Province, Vietnam 63. Indira Gandhi Krishi Vishwa Vidyalaya (IGKV), Raipur, Chhattisgarh 64. ICAR-Directorate of Groundnut Research (DGR), Junagadh, Gujarat, India 65. College of Forestry, Ranichauri (VCSG Uttarakhand University of Horticulture & Forestry), Bharsar 66. ICAR-Vivekananda Institute of Hill Agriculture, Almora, Uttarakhand 67. Krishi Vigyan Kendra-ICAR, Namthang, Sikkim 68. Hill Millet Research Station, Waghai-304730, Gujarat 69. Tribal Agricultural Research Station, Dindori, Madhya Pradesh 70. Assam Agricultural University, RARS, Telipara Gossaigaon 71. State Agricultural Research station, ARUNDHATI Nagar, Agartala, Tripura

		72. Nepal Agricultural Research Council, Nepal 73. Agricultural Research Station (ARS-SAU), Kota, Rajasthan 74. University of Agricultural Sciences-Raichur, Karnataka, India 75. Agriculture Research Station (ARS-MPUAT), Banswara, Rajasthan 76. Agriculture Research Station (ARS-SKRAU), Sriganganagar, Rajasthan 77. Banda University of Agriculture and Technology (BUAT), Banda, Uttar Pradesh 78. Bidhan Chandra Krishi Vishwavidyalaya (BCKV), Mohanpur, West Bengal 79. Bihar Agricultural University (BAU), Sabour, Bihar 80. Central Agricultural University (CAU), Imphal, Manipur 81. Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Hisar, Haryana 82. College of Agriculture (COA-RVSKVV), Indore, Madhya Pradesh 83. ICAR-Indian Institute of Pulses Research (ICAR-IIPR), Bhopal, Madhya Pradesh 84. RAK College of Agriculture, (RVSKVV) Sehore, Madhya Pradesh 85. Rajasthan Agricultural Research Institute (RARI-SKNAU), Jaipur, Rajasthan 86. Rani Lakshmi Bai Central Agricultural University (RBLCAU), Jhansi, Uttar Pradesh 87. Regional Agriculture Research Station (RARS-AAU), Shillongani, Meghalaya 88. Tirhut College of Agriculture (TCA-DRPCAU), Dholi, Bihar 89. Ethiopian Institute of Agricultural Research (EIAR), Debre Zeit Agricultural Research Center, Debre Zeit, Ethiopia 90. Tanzania Agricultural Research Institute (TARI), Tanzania 91. Kenya Agricultural and Livestock Research Institute (KALRO) 92. National Semi-Arid Resources Research Institute (NaSARRI), Uganda 93. Agricultural Research Institute (ARC), Sudan 94. National Agricultural Research Institute (NARI), Eritrea 95. Department of Agricultural Research Services (DARS), Malawi 96. Egerton University, Kenya 97. University of Nairobi, Kenya 98. Makerere University Regional Centre for Crop Improvement (MaRCCI), Kampala, Uganda 99. Instituto de Investigacao Agraria de Mozambique (IIAM) 100. BioWISH Co, USA 101. Rongo University, Kenya 102. Department of Agricultural and Extension Services (DAES), Malawi 103. Tanzania Agricultural Research Institute (TARI), Tanzania 104. Centre for Agriculture Transformation (CAT) 105. Lilongwe University of Agriculture and Natural Resources (LUANAR) 106. University of Zambia 107. Sokoine University of Agriculture (SUA)-Tanzania 108. National Semi-Arid Resources Research Institute (NaSARRI), National Agricultural Research Organization (NARO), Uganda 109. Nabuin Zonal Agricultural Research and Development Institute (Nabuin ZARDI), National Agricultural Research Organization (NARO), Uganda 110. National Agricultural Research Organization (NARO), Uganda 111. Melkassa Agricultural Research, Ethiopian Institute of Agricultural Research (EIAR), Ethiopia 112. National Agricultural Research Institute (NARI), Ethiopia 113. Selian Agricultural Research Institute, Ilonga Agricultural Research Institute, Kilosa; Lake Zone Agricultural Research and Development Institute, Ukiriguru, Tanzania 114. Zambia Agricultural Research Institute 115. Agrosoy seeds, Dryland Seeds Ltd, Faidha Seeds 116. Crop Breeding Institute (NARS), Zimbabwe 117. Seed Co, Zimbabwe 118. NARS, Agronomy Research Institute, Zimbabwe

		119. Zimbabwe Super Seed 120. Klein Karoo Seed (K2) 121. Champion Seed 122. Good Nature Seed 123. IER, Bamako, Mali 124. INERA, Ouagadougou, Burkina Faso 125. INRAN, Niamey, Niger 126. ISRA, Dakar, Senegal 127. CSIR, Accra, Ghana 128. ITRA, Lomé, Togo 129. INRAB, Cotonou, Benin 130. ITRAD, Ndjamena, Chad 131. IRAD, Yaoundé, Cameroun 132. Centre for Dryland Agriculture, Bayero University Kano (CDA-BUK) 133. IFDC. Mr Salasi Idris sidris@ifdc.org 134. National Centre for Genetic Resource and Biotechnology (NACGRAB), Moor Plantation, Ibadan 135. National Agricultural Extension and Rural Liason Services, ABU Zaria, Nigeria 136. Agricultural Research Council of Nigeria, Abuja, Nigeria
2	Crop Protection & Seed Health	1. Department of Agriculture Research Services (DARS), Malawi 2. Zambia Agriculture Research Institute 3. IIAM, Mozambique 4. KALRO, Kenya 5. NaSARRI, Uganda 6. ICAR-Indian Institute of Pulses Research (IIPR), Kanpur. 7. Bangladesh Agricultural Research Institute (BARI), Bangladesh 8. Ethiopian Institute of Agricultural Research (EIAR), Ethiopia 9. Indian Institute of Chemical Technology, Hyderabad, India 10. University of Agricultural Sciences, Raichur, Karnataka, India 11. University of Agricultural Sciences, Bengaluru, Karnataka, India 12. Professor Jayashankar Telangana State Agricultural University, Hyderabad, India 13. University of Agriculture and Horticulture Sciences, (UAHS), Shivmoga, Karnataka, India 14. South Asian Biotechnology Centre, New Delhi, India 15. ICAR-AICRP on Pearl Millet 16. ICAR-Indian Institute of Millets Research (IIMR), Hyderabad, India
3	Genomics, pre-breeding and Bioinformatics	1. Aberystwyth University, UK 2. Cambridge University, UK 3. Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), India 4. University of Agricultural Sciences, Dharwad, Karnataka, India 5. ICAR-Indian Institute of Millets Research (IIMR) 6. Vasantrao Naik Marathwada Agricultural University, Parbhani, Maharashtra, India 7. Tamil Nadu Agricultural University, Coimbatore 8. Professor Jayashankar Telangana State Agricultural University, Hyderabad, India 9. WACCI, University of Ghana, Ghana 10. Vignan University, Guntur, Andhra Pradesh, India 11. Tanzania Agricultural Research Institute (TARI)-Makutupora, Tanzania 12. IER, Mali 13. IBP, CIMMYT, Mexico 14. EiB (M#2, 3, 5), CIMMYT, Mexico 15. University of Essex, UK 16. University of Mysore, India

		17. King Abdullah University of Science and Technology (KAUST), Saudi Arabia 18. University of Nairobi, Kenya 19. University of Niamey, Niger 20. Institut Technologie Alimentaire (ITA), Dakar, Senegal 21. Institute of Research for Development (IRD), France 22. Corteva Agriscience, India 23. USDA-ARS, Crop Genetics and Breeding Research Unit, Tifton, USA 24. ICAR-Directorate of Groundnut Research (DGR), Junagadh, India 25. University of Georgia, USA 26. University of Southern Queensland, Australia 27. Acharya NG Ranga Agricultural University, Andhra Pradesh, India 28. Institut Sénégalais de Recherches Agricoles (ISRA), Centre Régional d'Excellence sur les céréales sèches et cultures associées, Senegal 29. Junagadh Agricultural University, India 30. ICAR - Indian Institute of Pulses Research 31. Ethiopian Institute of Agricultural Research (EIAR) 32. University of Giessen, Germany 33. Kenyatta University, Kenya 34. Kenya Agricultural and Livestock Research Organisation (KALRO), Kenya 35. Maseno University, Kenya 36. National Agricultural Research Organization, Uganda 37. Zambia Agricultural Research Institute, Zambia 38. Makerere University Regional Centre for Crop Improvement, Uganda 39. African Centre for Crop Improvement (ACCI), South Africa
4	Cell & Molecular Biology and Trait Engineering	1. Centre for Crop Science, The University of Queensland, Australia 2. VIB – Gent University, Belgium 3. Plant Stress and Germplasm Development Unit, Lubbock, USDA-ARS 4. Southern Regional research Centre (SRRC), New Orleans, USA 5. Michigan State University, USA 6. Biotech Consortium of India Ltd 7. APAARI, Bangkok, Thailand
5	Genebank	1. University of Nebraska–Lincoln, USA 2. University of Georgia, USA 3. Tamil Nadu Agricultural University, Tamil Nadu, India 4. University of Hyderabad, Telangana, Hyderabad, India 5. Indian Institute of Millets Research (IIMR), Hyderabad, India 6. National Bureau of Plant Genetic Resources, New Delhi 7. Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora 8. Madras Diabetes Research Foundation, Chennai 9. NordGen 10. Svalbard Global Seed Vault, Norway 11. Crop Trust 12. University of Maradi, Niger 13. University of Zimbabwe 14. University of Niamey, Niger 15. IPK, Germany

6	Crop Physiology and modelling	1. CIRAD- UMR AGAP, Montpellier Cedex 5, France 2. Indian Institute of Technology Bombay, Mumbai, India 3. CSIRO Plant Industry, Perth, Australia 4. School of Food Science and Nutrition, University of Leeds, UK 5. The University of Queensland, Queensland Alliance for Agriculture and Food Innovation, Brisbane, Australia 6. University of California, Davis, USA 7. Fraunhofer Development Center X-Ray Technology, Fürth, Germany 8. Université de Montpellier, France 9. The University of Queensland, Brisbane, Australia 10. University of Tokyo, Japan 11. University of Life Sciences, Prague, Czech Republic 12. Ethiopian Institute of Agricultural Research (EIAR), Debre Zeit Research Center, Ethiopia 13. Hone Pty Ltd, Australia 14. CORTEVA Agriscience, USA 15. ICAR-Indian Institute of Millets Research, Hyderabad, Telangana, India 16. Phenospex Pvt Ltd, The Netherlands 17. Institute of Biological, Environmental and Rural Sciences (IBERS), Aberystwyth University, UK 18. Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran 19. International Center for Tropical Agriculture (CIAT), Cali, Colombia 20. Grain Legume Genetics and Physiology Research, USDA-ARS, and Washington State University, Pullman, USA 21. University of Vermont, and Gund Institute for the Environment, Burlington, USA 22. Institute of Biological, Environmental and Rural Sciences (IBERS), Aberystwyth University, UK
7	Seed Systems	1. ICAR-IARI, New Delhi 2. Professor Jayashankar Telangana State Agricultural University (PJTSAU), Hyderabad, India 3. PDKV, Akola 4. GBPUAT, Pantnagar 5. RVSKVV, Gwalior 6. Tanzania Official Seed Certification Institute (TOSCI), Tanzania 7. Tanzania Seed Traders Association (TASTA), Tanzania 8. Pearl Seed Ltd, Uganda 9. Nalweyo Seed Company (NASECO), Uganda 10. Department of Agricultural and Extension Services (DAES), Malawi 11. Tanzania Agricultural Research Institute (TARI), Tanzania 12. ECOWAS 13. UEMOA 14. CILSS 15. CORAF 16. National Agricultural Seeds Council of Nigeria (NASC), Abuja, Nigeria 17. Centre for Dryland Agriculture (CDA), Kano, Nigeria

8	Climate adaptation and mitigation	1. ICAR-Central Research Institute for Dryland Agriculture (CRIDA) 2. EPTRI, Hyderabad 3. IMD 4. IITM 5. WorldFish 6. CIMMYT 7. Ethiopian Institute of Agricultural Research (EIAR) 8. AGRHYMET 9. Institut Senegalais de Recherche Agricole (ISRA) 10. Ministry of Agriculture and Natural Resources, Ethiopia 11. Institut National de Recherche Agricole du Bénin (INRAB) 12. Institut de l'Environnement et de Recherches Agricoles (INERA) 13. Institut de Recherche Agricole pour le Développement (IRAD) 14. Instituto National de Investigacäo e 15. Desenvolvimento Agrärio (INIDA) 16. Institut Centrafricain de la Recherche Agronomique (ICRA) 17. Institut National de Recherche Agronomique (IRA), Congo 18. Centre National de Recherche Agronomique (CNRA),Cote d'Ivoire 19. Institut de Recherches Agronomiques et Forestières (IRAF), Gabon 20. Council for Scientific and Industrial Research (CSIR), Ghana 21. Institut de Recherche Agronomique de Guinée (IRAG) 22. KARI, Kenya
9	Landscapes, soil fertility and water management	1. International Institute of Tropical Agriculture (IITA) 2. International Livestock Research Institute (ILRI) 3. World Vegetable Center (WorldVeg) 4. Institut d'Economie Rurale (IER) 5. Tanzanian Agricultural Institute (TARI) 6. Ethiopian Institute of Agricultural Research (EIAR)
10	Geospatial and Big data sciences	1. ICAR-National Bureau of Soil Survey and Land Use Planning (ICAR-NBSS&LUP), Nagpur, MH, India 2. Professor Jayashankar Telangana State Agricultural University (PJTSAU), Hyderabad, India 3. Acharya NG Ranga Agricultural University, Andhra Pradesh, India 4. Mahalanobis National Crop Forecast Centre (MNCFC), New Delhi, Government of India 5. United States Aid for International Development (USAID) 6. Michigan State University, USA 7. Asian Development Bank (ADB), The Philippines 8. Swiss Agency for Development and Cooperation (SDC) 9. SARMAP, Switzerland
11	Digital Agriculture	1. Plantix, Germany 2. Jiva Agri Tech, Singapore 3. University of Stirling, UK 4. University of Strathclyde, UK 5. KCT Group of Institutes 6. Policy4Tomorrow 7. Tetra Tech, USA

12	Agribusiness Innovation Platform	1. Department of Agricultural Marketing & Agribusiness, Government of Tamil Nadu, India 2. Telangana State Scheduled Tribes Cooperative Finance Corporation Ltd. (TROCOR), Govt. of Telangana, India 3. Department of Tribal Welfare, Govt. of Telangana, India 4. Integrated Tribal Development Agency (ITDA), Telangana, India 5. Professor Jayashankar Telangana State Agricultural University (PJTSAU), Telangana, India 6. ICAR-Indian Institute of Millets Research (ICAR-IIMR), Hyderabad, India
13	ICRISAT Development Center (IDC)	1. ICAR-Central Agro-Forestry Research Institute (CAFRI) 2. ICAR- Indian Grassland and Fodder Research Institute (IGFRI)
14	Nutrition, dietary behaviour and Smart Food	1. Egerton University, Kenya 2. National Institute of Nutrition (NIN), Indian Council of Medical Research, India 3. NNEdPRO Global Centre for Nutrition and Health, HQ in UK & Regional office in India 4. National Technical Board of Nutrition, Government of India, India 5. Bahir Dar University, Ethiopia
15	Gender and Youth	1. Home Science Colleges under State Agricultural Universities of Telangana and Andhra Pradesh, India 2. Acharya NG Ranga Agricultural University, Andhra Pradesh, India 3. Central Agro-forestry Research Institute (CAFRI), Jhansi, India
16	Technology Adoption and Impact Analysis	1. Kenya Agricultural & Livestock Research Organization (KARLO), Kenya 2. Ethiopian Institute of Agricultural Research (EIAR), Ethiopia 3. Tanzania Agricultural Research Institute (TARI), Tanzania 4. National Agricultural Research Organisation (NARO), Uganda 5. Acharya N G Ranga Agricultural University (ANGRAU), Guntur 6. Professor Jayashankar Telangana State Agricultural University (PJTSAU), Hyderabad 7. Gokhale Institute of Political and Economics, Pune, India 8. Matopos Research Institute, Zimbabwe 9. Lupane State University, Zimbabwe 10. University of Ghana 11. Initiative Prospective Agricole et Rurale (IPAR), Senegal
17	Markets, Institutions and Policy	1. ICAR- National Institute for Agricultural Economics and Policy Research, India 2. ICAR- Indian Agricultural Research Institute, New Delhi, India 3. EPTRI, Hyderabad 4. ICAR- Indian Institute of Millets Research 5. Bureau d'analyse Macro-économique (BAME), Senegal 6. J-PAL Asia 7. Center for Economic and Social Studies, Hyderabad 8. Institut Senegalais de Recherche Agricole (ISRA). Senegal 9. University of Agricultural Sciences, Dharwad, India 10. World Resource Institute 11. Indian Institute of Millets Research (IIMR), Hyderabad, India
18	Knowledge and Capacity Development	1. Foundation for Ecological Security/India 2. GIZ 3. RUFORUM 4. Earth University 5. Council for Tropical and Subtropical Agricultural Research (ATSAF e.V.) 6. Kalgudi 7. KUZA

C	Local Adaptive research partners KVKs, NGOs	
1	Crop Breeding	1. Professor Jayashankar Telangana State Agricultural University (PJTSAU), Telangana, India 2. University of Agricultural Sciences, Raichur, Karnataka 3. ICAR-VPKAS, Almora 4. Acharya NG Ranga Agricultural University, Andhra Pradesh, India 5. KVK, Baramati 6. Orissa University of Agriculture & Technology (OUAT), Bhubaneswar, Odisha 7. KVK, Bijapur, Karnataka 8. Loksebak, At- Naktiguda (Backside of Old Income Tax Colony), P.O.- Bhawanipatna, Dist.- Kalahandi, Odisha- 766001 9. Lokadrusti, At- Gadramunda, P.O.-Chindaguda, Dist.- Nuapada, Odisha-766107 10. NIRDES, At/PO- Jagannath Prasad (towards Bhanjanagar), District- Ganjam, Pin-761121, Odisha 11. Agricultural Research Station (ARS-SAU), Kota, Rajasthan 12. Agricultural Research Station (ARS-VNMKV), Badanpur, Maharashtra 13. Agriculture Research Station (ARS-MPUAT), Banswara, Rajasthan 14. Agriculture Research Station (ARS-SKRAU), Sriganganagar, Rajasthan 15. Banda University of Agriculture and Technology (BUAT), Banda, Uttar Pradesh 16. Bidhan Chandra Krishi Vishwavidyalaya (BCKV), Mohanpur, West Bengal 17. Bihar Agricultural University (BAU), Sabour, Bihar 18. Birsa Agricultural University (BAU), Ranchi, Jharkhand 19. Central Agricultural University (CAU), Imphal, Manipur 20. Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Hisar, Haryana 21. College of Agriculture (COA-RVSKVV), Indore, Madhya Pradesh 22. G. B. Pant University of Agriculture & Technology (GBPUA&T), Pantnagar, Uttarakhand 23. Indian Agricultural Research Institute (IARI), Pusa, New Delhi 24. Indira Gandhi Krishi Vishwa Vidyalaya (IGKV), Raipur, Chhattisgarh 25. Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur, Madhya Pradesh 26. Pulses Research Station, JAU, Junagadh, Gujarat 27. Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Maharashtra 28. Punjab Agricultural University (PAU), Ludhiana, Punjab 29. Punjabrao Deshmukh Krishi Vishwa Vidyalaya (PDKV), Akola, Maharashtra 30. RAK College of Agriculture, (RVSKVV) Sehore, Madhya Pradesh 31. Rajasthan Agricultural Research Institute (RARI-SKNAU), Durgapura, Jaipur, Rajasthan 32. Rani Lakshmi Bai Central Agricultural University (RBLCAU), Jhansi, Uttar Pradesh 33. Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu 34. Tirhut College of Agriculture (TCA-DRPCAU), Dholi, Bihar 35. University of Agricultural Sciences (UAS), Vijayapura & Dharwad, Karnataka 36. Department of Agricultural Research (DAR), Yezin, Nay Pyi Taw, Myanmar 37. Ethiopian Institute of Agricultural Research (EIAR), Debre Zeit Agricultural Research Center, Debre Zeit, Ethiopia 38. Tanzania Agricultural Research Institute (TARI), Ukiriguru, Mwanza, Tanzania 39. Estacion Experimental Agroindustrial Obispo Colombres Av. William Cross 3150/CC: Nº 9 (T4101XAC), Las Talitas/Tucumán, Argentina 40. Facultad de Cinencias Agropecuarin, Universidad Nacional de Córdoba, Argentina 41. Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh 42. The Department of Agricultural Research Services (DARS), Ministry of Agriculture, Malawi 43. The Benguet State University, Benguet, The Philippines 44. Odessa State Agricultural Research Station, Odessa Oblast, Ukraine

		45. Hi-Rich seeds Pvt Ltd 46. Daftari seeds Pvt Ltd 47. World Vision International 48. National Smallholder Farmers' Association of Malawi (NASFAM) 49. Ekwendeni Mission Hospital-Department of Agriculture, Malawi 50. Centre for Agriculture Transformation (CAT) 51. CARE, Malawi 52. AHBI, Kenya 53. World Vision, South Sudan 54. Community Development Technology Organisation 55. Weltehungehilfe 56. Plan International 57. Care International 58. Lead Trust Feed The Future Zimbabwe 59. SNV International 60. Direction Nationale de l'Agriculture DNA, Bamako, Mali 61. Programme National de Vulgarisation et d'Appui-Conseil Agricole, Burkina Faso 62. Direction de la Vulgarisation et du Transfert des Technologies, Niger 63. Federal University Dutsin-Ma. Maryam Ati 64. Usmanu Dan Fodio University Sokoto. Aliyu Umar 65. Federal University Wukari Taraba, Nigeria 66. Jigawa State Research Institute Kazaure, Umar Jaafar 67. AL-QALAM University, Katsina 68. Abubakar Tafawa-Balewa University Bauchi, Godwin
2	Crop Protection and Seed health	1. Catholic Relief Services (CRS) 2. CARE international 3. World Vision 4. Pheromone chemicals India Ltd, Hyderabad 5. ICAR-AICRP on Pearl Millet
3	Genomics, pre-breeding & Bioinformatics	1. All India Coordinated Research Project on Pearl Millet (AICRP-PM), Jodhpur, India 2. Indian Institute of Millets Research (IIMR), Hyderabad, India 3. Indian Agricultural Research Institute (IARI), New Delhi, India 4. CCS Haryana Agricultural University (CCSHAU), Hisar, India 5. University of Agricultural Sciences-Dharwad, India 6. ICAR-Directorate of Groundnut Research (DGR), Junagadh, India 7. Junagadh Agricultural University, India 8. Acharya NG Ranga Agricultural University, Andhra Pradesh, India 9. Professor Jayashankar Telangana State Agricultural University, Telangana, India 10. Various SAUs and seed companies from India, ESA and WCA
4	Cell and Molecular Biology and Trait Engineering	1. Kenyatta University, Nairobi, Kenya 2. CERAS, Senegal
5	Seed Systems	1. Hytech Seed India Pvt Ltd 2. K D Seeds 3. Rasi Seeds (P) Ltd 4. UPL Agro SA de CV 5. UPL Limited 6. Bioseed Research India 7. Gemini Seeds Pvt Limited 8. Nutranta Seeds Pvt Ltd 9. JK Agri Genetics Ltd. 10. Nu Genes Private Limited

		11. Nuziveedu Seeds Pvt Limited 12. Vanya Hybrid Seeds LLP 13. Earthnote Co Ltd 14. MISR Hytech Seed Int SAE 15. Super Seeds Pvt Ltd 16. Classic Hybrid Seeds Private Limited 17. Seed Traders Association of Malawi (STAM) and its membership 18. Malawi Seed Alliance (MASA) and its membership –seed companies 19. National Smallholder Farmers' Association of Malawi (NASFAM) 20. Ekwendeni Mission Hospital-Department of Agriculture, Malawi 21. CARE, Malawi 22. Kenya Seed Company 23. Dryland Seeds Co, Kenya 24. Freshco Seeds, Kenya 25. Faida Seeds Co., Kenya 26. East Africa Seed Co, Kenya 27. Misr Hytech Sed Co, Egypt 28. Niesun Seeds, Sudan 29. Suba Agro Seeds, Tanzania 30. Seedco Ltd, Zimbabwe 31. Pearl Seeds, Uganda 32. NASECO Seed Co, Uganda 33. KWS-SE, DEEI (Seed Co), Germany 34. SATG, Somalia 35. Faso Kaba, Bamako, Mali 36. SOPROSA SARL, Sikasso, Mali 37. AGRI PLUS SARL, Koutiala, Mali 38. CAMARA SEMENCES SARL, Kassela, Mali 39. DUNKAFA SARL, Bamako, Mali 40. NAFASO, Bobo-Dioulasso, Burkina Faso 41. FAGRI SARL, Ouagadougou, Burkina Faso 42. Techni Seeds 43. Premier Seeds 44. Greenspore Alh. Balarabe Shehu 45. Usman Danfodio University (UDUS), Sokoto, Nigeria 46. Jigawa Research Institute (JRI), Jigawa State, Nigeria
6	Climate adaptation and mitigation	1. OUAT, Bhubaneswar, Odisha 2. ANGRAU, Andhra Pradesh, India 3. National meteorological agencies 4. AMEDD 5. National extension services
7	Landscapes, soil fertility and water management	1. Association Malienne d'Eveil au Developpement Durable (AMEDD) 2. Cooperatives of the Mouvement Biologique du Mali (FENABE) 3. LEAD Foundation
8	Geospatial and Big data sciences	1. National Institute of Rural Development, India 2. NIRUTHI, India 3. Jawaharlal Nehru Technological University (JNTU), India 4. Agritech Innovations
9	Digital Agriculture	1. Dr Reddy's Foundation 2. Neta Analytics, UK 3. Kuza Biashare, Kenya

10	Agribusiness Innovation Platform	1. NIRMAN Organization, India
11	Nutrition, dietary behaviour and Smart Food	1. ICDS CDPOs, India 2. MPSWA, Myanmar
12	Markets, Institutions and Policy	1. Krishi Vigyan Kendras of ICAR and SAUs, India 2. EPTRI, Government of Telangana 3. ICAR- Indian Institute of Farming Systems Research 4. World Resource Institute
13	ICRISAT Development Center (IDC)	1. BAIF Institute for Sustainable Livelihoods and Development (BISLD-UP) 2. Heirloom Seedlings and Plants Private Limited 3. Vasudhaika Software Pvt Ltd 4. Weather Risk Management Services Pvt Ltd (WRMS) 5. BASIX Consulting and Technology Services Limited 6. Satpuda Education Society's Krishi Vigyan Kendra
14	Technology adoption and Impact Analysis	1. Acharya NG Ranga Agricultural University, Andhra Pradesh, India 2. Professor Jayashankar Telangana State Agricultural University (PJTSAU), Hyderabad, India 3. Tamil Nadu Agricultural University (TNAU), India
15	Gender and Youth	1. Independent Consultants, India 2. Kalinga Institute of Social Studies (KISS), Odisha, India
16	Knowledge and Capacity Development	1. Foundation for Ecological Security/India
D	Scaling for Impact	
1	Crop breeding	2. PRAN Agro business Ltd., PRAN-RFL Group, Dhaka, Bangladesh 3. Telangana State Seeds Development Corporation Ltd. (TSSDC), Hyderabad, Telangana, India 4. Hindustan Insecticides Limited (HIL), Hyderabad, India 5. Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana, India 6. University of Agricultural Sciences, Raichur, Karnataka, India 7. Acharya NG Ranga Agricultural University, Andhra Pradesh, India 8. KVK, Baramati 9. Orissa University of Agriculture & Technology (OUAT), Odisha, India 10. Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, Maharashtra, India 11. Indian Council of Agricultural Research (ICAR) 12. Agricultural Research Station (ARS-SAU), Kota, Rajasthan 13. Agricultural Research Station (ARS-UAS), Kalaburagi, Karnataka 14. Agricultural Research Station (ARS-VNMKV), Badanpur, Maharashtra 15. Agriculture Research Station (ARS-MPUAT), Banswara, Rajasthan 16. Agriculture Research Station (ARS-SKRAU), Sriganganagar, Rajasthan 17. Banda University of Agriculture and Technology (BUAT), Banda, Uttar Pradesh 18. Bidhan Chandra Krishi Vishwavidyalaya (BCKV), Mohanpur, West Bengal 19. Bihar Agricultural University (BAU), Sabour, Bihar 20. Birsa Agricultural University (BAU), Ranchi, Jharkhand 21. Central Agricultural University (CAU), Imphal, Manipur 22. Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Hisar, Haryana 23. College of Agriculture (COA-RVSKVV), Indore, Madhya Pradesh 24. G B Pant University of Agriculture & Technology (GBPUA&T), Pantnagar, Uttarakhand

		25. ICAR-Indian Institute of Pulses Research (ICAR-IIPR), Bhopal, Madhya Pradesh 26. Indian Agricultural Research Institute (IARI), Pusa, New Delhi 27. Indira Gandhi Krishi Vishwa Vidyalaya (IGKV), Raipur, Chhattisgarh 28. Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur, Madhya Pradesh 29. Pulses Research Station, Junagadh Agricultural Univerity (JAU), Junagadh, Gujarat 30. Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Maharashtra 31. Punjab Agricultural University (PAU), Ludhiana, Punjab 32. Punjabrao Deshmukh Krishi Vishwa Vidyalaya (PDKV), Akola, Maharashtra 33. RAK College of Agriculture, (RVSKVV) Sehore, Madhya Pradesh 34. Rajasthan Agricultural Research Institute (RARI-SKNAU), Jaipur, Rajasthan 35. Rani Lakshmi Bai Central Agricultural University (RBLCAU), Jhansi, Uttar Pradesh 36. Regional Agriculture Research Station (RARS-AAU), Shillongani, Meghalaya 37. Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu 38. Tirhut College of Agriculture (TCA-DRPCAU), Dholi, Bihar 39. University of Agricultural Sciences (UAS), Vijayapura and Dharwad, Karnataka 40. Department of Agricultural Research (DAR), Yezin, Nay Pyi Taw, Myanmar 41. Ethiopian Institute of Agricultural Research (EIAR), Debre Zeit Agricultural Research Center, Debre Zeit, Ethiopia 42. Grain Legume Research Program, Nepal Agricultural Research Council (NARC), Mid-West, Nepal 43. Tanzania Agricultural Research Institute (TARI), Ukiriguru, Mwanza, Tanzania 44. Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh 45. The University of Swabi Swabi-Khyber Pakhtunkhwa, Pakistan 46. The Department of Agricultural Research Services (DARS), Ministry of Agriculture, Malawi 47. Agriculture Research and Development Centre, Sarpang, Bhutan 48. The Benguet State University, Benguet, The Philippines 49. Hi-Rich seeds Pvt Ltd 50. Daftari seeds Pvt Ltd 51. Africa Harvest Biotechnology International (AHBI) 52. Ministry of Agriculture-Extension Services in ESA countries 53. National Smallholder Farmers' Association of Malawi (NASFAM) 54. Ekwendeni Mission Hospital-Department of Agriculture, Malawi 55. Dodoma Agriculture Seed Producers Association (DASPA), Tanzania 56. Kibaigwa Flour Suppliers Company (KFS) 57. Department of Agricultural and Extension Services (DAES), Malawi 58. Tanzania Agricultural Research Institute (TARI),Tanzania 59. EastCom Foods Company, Kenya 60. Community Action for Rural Development, Kenya 61. Sorghum Pioneer Agency, Kenya 62. Family Diet Ltd, Uganda 63. Community Development Technology Organisation 64. Weltehungehilfe 65. Plan International 66. Care International 67. Lead Trust Feed The Future, Zimbabwe 68. SNV International 69. EUCORD, Bamako, Mali 70. MALIMARK, Bamako, Mali 71. AMASSA- Afrique Verte, Bamako, Mali 72. World Food Program (Resilient program): Badalabougou Est, Rue 31, Porte 26 – BP120

		73. Save the Children, Bamako, Mali 74. Catholic Relief Services, Bamako, Mali 75. World Vision, Bamako, Mali 76. AOPP, Bamako, Mali 77. ULPC de Dioïla, Cercle de Dioïla, Mali 78. UGCPA/BM, Ouagadougou, Burkina Faso 79. FEPAB-Burkina Faso, 01 Bama Bagnomo. Christophe. FEPA-B. Chargé du. CEF. 70 94 70 82 80. UGPCA-Burkina, Dedougou, Burkina Faso 81. Mooriben, Niamey, Niger 82. Fuma Gaskiya, Maradi, Niger 83. AGRA, Bamako, Mali 84. International Fund for Agricultural Development (CASP-Katsina Head office) 85. International Fund for Agricultural Development, Sokoto 86. International Fund for Agricultural Development, Yobe 87. Fadama III-AF, Katsina 88. Fadama III-AF, Kano 89. Fadama III-AF, Bauchi 90. Green Sahel 91. Women Farmers Advancement Network (WOFAN), Opposite Bayero University, Kano (BUK), Newsite Gate, Hajiya Salamatu Garba
2	Crop Protection and Seed Health	1. Centre for Agriculture Transformation (CAT), Malawi 2. Department of Agriculture, Govt. of Odisha, India 3. Private sector partners in India (Corteva, Ganga Kaveri, Hytech Seeds, Bayer Bioscience, Nandi Seeds, Metahelix, Rasi Seeds, Rallis India Limited)
3	Genomics, pre-breeding & Bioinformatics	1. All India Coordinated Research Project on Pearl Millet (AICRP-PM), Jodhpur, India 2. Various SAUs from India, ESA and WCA 3. Various NGOs/KVKs and seed companies from India and Africa

4	Seed Systems	1. Maharashtra State Seeds Co. Ltd. (MSSC), India 2. Andhra Pradesh State Seeds Development Corporation Ltd. (APSSDC), Andhra Pradesh, India 3. Telangana State Seeds Development Corporation Ltd. (TSSDCL), Hyderabad, Telangana, India 4. Greenpetal Infra & Resources Pvt Ltd 5. Paani Foundation 6. National Smallholder Farmers' Association of Malawi (NASFAM) 7. Ekwendeni Mission Hospital-Department of Agriculture, Malawi 8. Dodoma Agriculture Seed Producers Association (DASPA),Tanzania 9. Kibaigwa Flour Suppliers Company (KFS) 10. Department of Agricultural and Extension Services (DAES), Malawi 11. Tanzania Agricultural Research Institute (TARI),Tanzania 12. Faso Kaba, Bamako, Mali 13. SOPROSA SARL, Sikasso, Mali 14. AGRI PLUS SARL, Bamako, Zamoho: Koutiala, Mali 15. CAMARA SEMENCES SARL, Kassela, Mali 16. DUNKAFA SARL, Bamako 17. NAFASO, Bobo-Dioulasso, Burkina Faso 18. FAGRI SARL, Ouagadougou, Burkina Faso 19. Techni Seeds 20. Premier Seeds, Nigeria 21. Greenspore Alh. Balarabe Shehu 22. Northern Nigeria Flour Mills, Kano, Nigeria 23. Honeywell Flour Mills, Lagos, Nigeria 24. Dala foods, Kano, Nigeria 25. Nigerian Breweries Ltd., Kaduna, Nigeria 26. Lima Africa Company Limited (LIMA AFRICA), Tanzania 27. Alssem Company Limited (ALSSEM), Tanzania 28. Temnar Company Limited (TEMNAR), Tanzania 29. Mbozi Highland Economic Group Company Limited (MHEG), Tanzania 30. Rieta Agro Sciences Tanzania Limited, Tanzania 31. Pavig Agro Company Ltd (PAVIG AGRO), Tanzania 32. Agriseed Technologies Ltd (AGRISEED), Tanzania 33. ZASSE Agricultural Seed and Food Company Limited (ZASFCO LTD), Tanzania 34. Agricultural Seed Agency (ASA), Tanzania 35. Equator Seeds, Uganda 36. Legacy Crop Improvement Center, Ghana 37. Value Seeds, Nigeria 38. Green Sahel Ltd 39. State-based Agricultural Development Projects/Programs 40. Pearl Seed, Uganda
5	Climate adaptation and mitigation	1. MANOBI AFRICA PLC 2. Green Agro Solution Ltd. 3. ECOWAS 4. SADEC 5. CORAF 6. CCARDESA 7. ESOKO 8. JOKALANTE 9. MYAGRO

6	Landscapes, soil fertility and water management	1. Care-Mali International 2. SAS-Tanzania
7	Geospatial and Big data sciences	1. Krishi Vigyan Kendras (KVKs) in Madhya Pradesh, Odisha, Karnataka
8	Digital Agriculture	1. InDeve Consultancy 2. Source Trace 3. SR Global 4. Verdentum 5. Sankethika Consulting 6. Kalgudi
9	Agribusiness and Innovation Platform	1. Walmart Foundation 2. Accion Fraterna Ecology Center, Anantapur, India 3. Samunnati Financial Intermediation & Services Private Limited, India 4. Forum for Agricultural Research in Africa (FARA), Ghana 5. AFNii- Invest India 6. National Dairy Development Board (NDDB), India 7. Dr. Reddy's Foundation, Hyderabad, India
10	Nutrition, dietary behaviour and Smart Food	1. Vétérinaires sans Frontières, Swiss 2. ICDS frontline workers- Anganwadi teachers and Accredited Social Health Activist (ASHA) workers, India 3. NNEdPRO Global Centre for Nutrition and Health, HQ in UK, Regional office in India 4. World Food Program (WFP) 5. Greenforest Ltd Kenya
11	Markets, Institutions and Policy	1. Dabur India Limited 2. VSF-Suisse 3. Foundation for Ecological Sustainability 4. Government of Telangana 5. World Resource Institute
12	ICRISAT Development Center (IDC)	1. Society for Community Organization & People's Education (SCOPE) 2. Upman Mahila Sansthan 3. Lakshya Seva Samiti 4. Gram Unmesh Sansthan 5. Gramin Vikas Kendra 6. Samarpan Jan Kalyan Samiti 7. Samarth Foundation 8. Gramonnati Sansthan 9. Highlands Agriventure Limited (HAVL) 10. Jana Kalyan Pratisthan 11. Harsha Trust 12. Foundation for Ecological Security (FES) 13. Manjeera Watershed Committee 14. Singur Watershed Committee 15. Samatha Society for Rural Education and Development, Anantapur, Andhra Pradesh 16. Kondampalli Watershed Committee 17. BISLD (Baif Institute for Sustainable Livelihoods and Development) 18. Wanaparthy Watershed Committee 19. Rural Integrated Development Society (RIDS) 20. Janasahajya 21. Saila Srikhetra Watershed Committee 22. Rural Education and Agricultural Development (READ)

		23. Pragati Bahuuddesiya Sevabhavi Sanstha (WC) 24. Rural Communes, Mumbai
13	Technology adoption and Impact Analysis	1. Acharya NG Ranga Agricultural University, Andhra Pradesh, India 2. Odisha University of Agriculture and Technology (OUAT), Odisha, India 3. Odisha Livelihoods Mission (OLM) 4. Odisha PVTG Employment and Livelihoods (OPELIP)
14	Knowledge and Capacity Development	1. Foundation for Ecological Security, India 2. Victoria Lake Basin Commission 3. One CGIAR

ICRISAT Locations

About ICRISAT

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

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 its donors to help overcome poverty, malnutrition and environmental degradation in the harshest dryland regions of the world.
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