

National Innovations in Climate Resilient Agriculture (NICRA)

Indian Council of Agricultural Research



Implemented by

Natural Resource Management Division (ICAR), New Delhi

Coordinated by

ICAR - Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad

Background

The impacts of climate change are global, but countries like India are highly vulnerable as large population depends on agriculture. The year 2016 ranks as the warmest year, 16 of the 17 warmest years in the 136 year record all have occurred since 2001. The Intergovernmental Panel on Climate Change (IPCC) in its recent report (SR 15) indicated that global average temperature is already more than 1°C higher than the pre-industrial era and every fraction of a degree temperature rise makes a big difference. At the current rate of emission, the world will reach 1.5°C warming by 2030 & 2052. The predicted temperature rise for India is in the range of 0.5–1.2°C by 2020, 0.88–3.16°C by 2050 and 1.56–5.44°C by the year 2080. Studies showed significant negative impacts of climate change, predicted to reduce yields by 4.5 to 9.0%, depending on the magnitude and distribution of warming. Agriculture sector is contributing about 17.4% of India's GDP, a 4.5-9.0% negative impact on production implies a cost of climate change to be roughly up to 1.5% of GDP per year. Enhancing agricultural productivity, therefore, is critical for ensuring food and nutritional security for all, particularly the resource poor small and marginal farmers who would be affected most. In the absence of mitigation and adaptation strategies, the consequences of long-term climate change could be even more severe on the livelihood security of the poor. Therefore climate change adaptation is no longer an option, it is a necessary. With this background the Indian Council of Agricultural Research (ICAR) under the Ministry of Agriculture and Farmers' Welfare, Government of India launched a flagship network project '*National Innovations in Climate Resilient Agriculture*' (NICRA) during 2011.

Climate Resilient Agriculture

There has been a significant rise in the frequency of extreme weather events in recent years affecting farm level productivity and impacting staple food grains availability at the national level. Within a season, severe droughts and floods are being experienced in the same region posing serious problems to the farmers, agricultural scientists and extension staff. Fall in yield leads to shortage of food grains, price rise and inflation affecting poor the most. Therefore, it is of utmost importance to enhance the resilience of Indian Agriculture to climate change. Both application of improved technologies and new policies will contribute to resilience. There is also abundant traditional wisdom among farmers to cope with climate variability which are being captured and documented in the project.

Since climate change poses complex challenges like multiple abiotic stresses on crops and livestock, shortage of water, land degradation and loss of biodiversity, a focused and long term research is required to find solutions to the problems specific to the country. The necessary infrastructure to carry out basic and strategic research has to be put in place. At the same time, there is a scope to improve the resilience of agriculture by application of existing knowledge and technology on farmers' field as a holistic package. Hence, in NICRA Project it is contemplated both to develop climate resilient technologies through short term and long term research, and also demonstrate the existing technologies on farmers' fields for enhancing the resilience

The scheme attempts to develop and promote climate resilient technologies in agriculture which will address vulnerable areas of the country. The outputs of the scheme will help the districts and regions prone to extreme weather conditions like droughts, floods, frost, heat waves, etc. to cope with such events. Although the target area of the scheme are all climatically vulnerable regions of the country, small and marginal farmers in rainfed, coastal and hill areas will benefit more in view of the focused attention in these regions.

Objectives

- To enhance the resilience of Indian agriculture to climatic variability and climate change through strategic research on adaptation and mitigation.
- To validate and demonstrate climate resilient technologies on farmer's fields.
- To strengthen the capacity of scientists and other stakeholders in climate resilient agriculture.
- To draw policy guidelines for wide scale adoption of resilience technologies and options.

Components of the Scheme

- Strategic research through network, sponsored and competitive grants.
- Technology demonstration and dissemination.
- Knowledge management.
- Capacity building.

In strategic research component, both short term and long term research programs with a national perspective have been taken up to evolve adaptation and mitigation strategies in crops, horticulture, natural resources, livestock, fisheries and poultry. About 41 ICAR Institutes representing different sectors of agriculture are undertaking climate change research in a network mode focusing the respective theme areas. Research proposals addressing critical gaps not covered in the strategic research component but have a major bearing of the productivity of principal commodities in that region are being funded through competitive and sponsored grants. So far, 18 Sponsored and 33 competitive projects have been funded to undertake critical areas of climate change research.

Simultaneously the existing technologies to cope with current climate variability is being demonstrated in 151 climatically vulnerable districts through 121 Krishi Vignan Kendras (KVKs), 23 Coordinating Centers of the All India Coordinated Research Project on Dryland Agriculture (AICRPDA) and 7 ICAR Institutes.

Unique Features of the Scheme

- Unique project which brings all the sectors of agriculture viz., crops, horticulture, livestock, fisheries, natural resources and extension scientists on one common platform to address the impending issue of climate change.
- Critical assessment of different districts in the country for vulnerability to climatic stresses and extreme events.
- Installation of state-of-the-art equipment like flux towers for continuous measurement of green house gases in large field areas to understand the impact of management practices on emissions.
- Rapid and large scale screening of germplasm including wild relative for drought, flood and heat tolerance through phenomics platforms for identification of promising genetic material and early development and release of heat / drought / flood tolerant crop varieties.
- Downscaling of climate change projections to study its impact on crops, livestock, fisheries and natural resources through integrated modeling approach.
- Comprehensive field evaluation of new and emerging approaches of crop cultivation like aerobic rice, Conservation Agriculture practices etc., for their contribution to reduce the GHG emissions.

- Special emphasis to livestock and fishery sectors including aquaculture which have not received enough attention in climate change research in the past. Identification and characterization of adaptive traits in the indigenous resilient breeds will be the most useful step.
- Thorough understanding of crop-pest / pathogen relationship and emergence of new biotypes due to climate change.
- Simultaneous up-scaling of the outputs both through KVKs and the National Mission on Sustainable Agriculture for wider adoption by the farmers.

TECHNICAL PROGRAM

Strategic Research

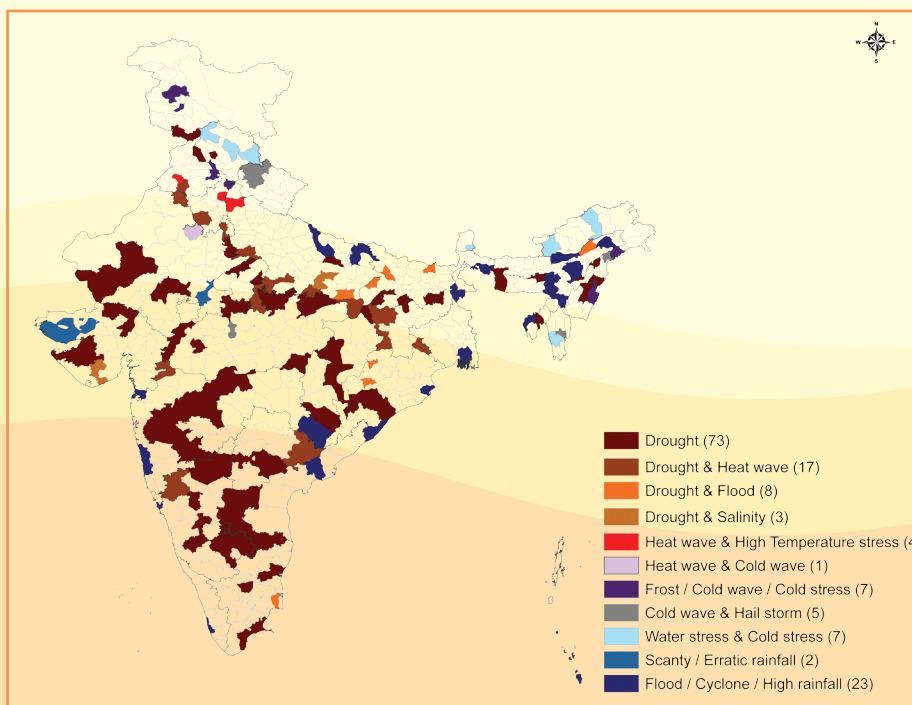
Activity	Institution and focus area
Integrated systems modeling involving crops, natural resources, fisheries and livestock for impact assessment and identifying adaptation strategies at regional level for near and long-term downscaled scenarios	IARI (wheat, rice), CRIDA (maize, pigeonpea), CPRI (potato), IIHR & DOGR (onion), NCIPM (pests & diseases of major field and horticulture crops) CRIDA (climate, rainwater, soil carbon), IISWC (basin level impacts) IWM (groundwater), IISS (soil data), NBSSLUP (carbon stocks) CMFRI (marine fisheries), CIBA (brackish water aquaculture) IIFSR (irrigated farming systems in IGP), NEH (hill farming system in NEH region), CRIDA (rainfed farming system)
Real time district / block level agro advisories for minimizing risk due to climate variation	CRIDA (through 25 AICRPAM network centers by piloting agro-advisories and in 121 KVKs)
Strengthening real time data capture on crop health through satellite data reception system & integrate the output for agro-advisories	IARI, CRIDA (through its 23 AICRIPAM network centers)
On-station and on-farm testing of contingency plans on real time basis to cope with monsoon variability / extreme weather events	CRIDA (through AICRPDA network in 23 agro-ecological sub-regions and in selected KVKs)
Genetic enhancement of tolerance to climatic stresses in major food and horticultural crops through phenomics- assisted and field-phenotyping	IARI (irrigated crops-rice & wheat), CRIDA (rainfed crops-maize, pigeonpea) for drought and heat stresses IIPR (chickpea, greengram, blackgram and lentil for climatic stresses) IIMR (drought, heat and multiple abiotic stress in maize) IIWBR (wheat for terminal heat stress) NRCPB (transgenic wheat for heat responsive genes) NRRI (identification of CO ₂ responsiveness genotypes and genetic enhancement for drought, submergence and salinity in rice) IIRR (rice genotypes for heat tolerance and nitrogen use efficiency) NEH (rice & maize - heat, drought & submergence, tomato - drought tolerant for north east regions) NIASM (mungbean, chickpea & pigeonpea for drought, heat & salinity tolerance), IIHR (mango & tomato for heat and drought) DOGR (onion), IIVR (tomato for water logging & high temperature), CITH (temperate fruits – apple & wall nut) for climatic stresses) NBPGR (rice and wheat for drought and heat) IIHR (mango for temperature and moisture stress)

Activity	Institution and focus area
Monitoring of GHG emissions through flux towers or field measurements and establish GHG inventory for different production systems	IARI (irrigated rice-wheat in IGP and transplanted rice-rice system in South-East peninsula), NRRI (rice-based production systems, irrigated and rainfed in coastal and central regions), CRIDA (rainfed - maize, pigeonpea, blackgram), IIFSR (IFS based systems), CSSRI (rice-wheat system in NW region), IGFRI (grassland and open grazing systems), NEH (NE zone production systems), NDRI (livestock), CIBA (aquaculture)
Adaptation and mitigation through (a) improved crop management, enhanced water productivity and nutrient use efficiency	CRIDA (rainwater management through watershed approach; carbon and nutrient budgeting in rainfed system), IARI (carbon and nutrient budgeting in rice-wheat), IIFSR and CRIDA (assessment of mitigation potential of IFS approach - irrigated and rainfed) NRRI (mitigation potential of improved management practices and inputs in rice cultivation), NEH (soil and rainwater management in hill production systems of NE region), IIFSR , CRIDA (improved water productivity in irrigated (IIFSR) and rainfed (CRIDA) production systems through rainwater harvesting and groundwater recharge), RCER (management of high intensity rain events in middle IGP for <i>kharif</i> crops and low temperature in eastern IGP for maize & boro rice) CSSRI (management of salinity and sea water intrusion due to climatic variability in coastal regions)
(b) Enhancing carbon sequestration and adaptation potential through Conservation Agriculture (CA), Soil Water Management (SWM) and agroforestry	CRIDA (CA, C-sequestration and nutrient use efficiency in rainfed cropping systems), CRIDA , CAZRI (quantification of C-sequestration potential in selected agroforestry systems in IGP, semi-arid and arid zones), NEH (C-sequestration through biomass recycling (e.g. biochar) and agroforestry modules in NE states), IIFSR (CA and C-sequestration in horticultural crops), IIFSR (management practices for enhanced C-sequestration in vertisols), IGFRI (C-sequestration in relation to grazing intensity in range lands)
(c) Enhanced energy use efficiency in agriculture	CAE , CRIDA (mitigation potential of enhanced energy use efficiency through precision farming)
Pest and disease dynamics in changing climate, development and validation of pest forecasting models and mobile applications	NCIPM , CRIDA (validation and refinement of pest forecast systems and integration with short-term and medium term weather forecast) IIFSR , NCIPM (rice-BPH, stem borer and leaf folder), IIFSR (wheat yellow rust), CRIDA , IIFSR (tri-trophic interactions of plant-pests-natural enemy to eCO ₂ and eTemp in rainfed and horticultural crops) IIFSR (tomato), RCER (mango), DOGR (onion)
Validation of unique genes and proteins for use as biomarkers of climate resilience; Physiological, genomics and nutrigenomic approaches for better feed conversion efficiency and enhanced productivity; amelioration of thermal stress using feed supplements and custom designed shelter systems	NDRI (cattle and buffalo), NEH (pig and poultry) IIFSR (cattle)
Climate variability and livestock vectors, pests & disease dynamics	NIVEDI (livestock diseases surveillance) IVRI (livestock diseases resistance traits)
Adaptation strategies in large and small ruminants and poultry to thermal stress through nutritional, shelter and environmental manipulations	NDRI , IVRI (cattle and buffalo) CIRG (goat), CSWRI , CRIDA , CAZRI (sheep), DPR in partnership with TANUVAS (poultry)

Activity	Institution and focus area
Impact assessment of climatic variations on ecosystem responses and development of adaptation and mitigation strategies	CMFRI (marine), CIFRI (inland), CIBA (brackishwater aquaculture) CIFA (freshwater aquaculture), DCFR (coldwater fisheries)
Carbon sequestration	CIFRI (inland), CMFRI (sea weeds), CAFRI (agro forestry systems) & IIHR, CRIDA (perennial horticultural system & other plants)
Modeling climate change impacts on abundance of key fisheries species, reproduction, behavior and distribution	CMFRI (marine), CIBA (brackishwater aquaculture), CIFRI (inland)
Assessment of macro and micro-level vulnerabilities and adaptation assessment. Development & validation of climate resilient indicators	CRIDA, NIAP (socio economics aspects and ecosystem services)
Policy research for facilitating adaptation and innovations in utilization of global adaptation funds	CRIDA (economic analysis of different adaptation options), NIAP (mainstreaming adaptation policies and to evolve strategies for utilization of global adaptation funds to bring resilience to Indian agriculture)

Technology Demonstration

It is being implemented in farmer participatory mode in 151 climatically most vulnerable districts of the country. The objective of this component is to enhance resilience in agriculture by demonstrating site specific climate resilient agricultural practices and to adopt these practices by farmers to cope with climate variability. The process of finalizing the demonstration package have the following steps viz., Analysis of climate constraints of village based on long term data, Assessment of natural resources status of the village, Identification of major production systems, Studying of existing institutional structures and identify the gaps and Consultations with the community to finalize the interventions.



The interventions covered the following four major modules:

Module I: Natural Resource Management

Interventions related to *in-situ* moisture conservation, biomass mulching, residue incorporation instead of burning, brown and green manuring, water harvesting and recycling for supplemental irrigation, improved drainage in flood prone areas, conservation tillage where appropriate, artificial ground water recharge and water saving irrigation methods.

Module II: Crop Production

Introducing drought/temperature tolerant varieties, advancement of planting dates of *rabi* crops in areas with terminal heat stress, water saving paddy cultivation methods (SRI, aerobic, direct seeding), frost management in horticulture through fumigation, staggered community nurseries for delayed monsoon, custom hiring centers for timely completion of farm operations, location specific intercropping systems with high sustainable yield index.

Module III: Livestock and Fisheries

Use of community lands for fodder production during droughts/floods, augmentation of fodder production through improved planting material, improved fodder/feed storage methods, fodder enrichment, prophylaxis, improved shelters for reducing heat stress in livestock, management of fish ponds/tanks during water scarcity and excess water and promotion of livestock component as a climate change adaptation strategy.

Module IV: Institutional Interventions

Institutional interventions either by strengthening the existing ones or initiating new ones relating to community seed bank, fodder bank, commodity groups, custom hiring centre, collective marketing group, introduction of weather index based insurance and climate literacy through a village weather station. The program also aims at development of an enabling mechanism at the village level for continued adoption of such practices in a sustainable manner.

Module on use of ICT for knowledge empowerment of the communities in terms of climate risk management is also being implemented in some KVKs for generation of locally relevant content and its dissemination in text and voice enabled formats. As an outcome of this exercise location specific climate resilient practices and constraints in its adoption are being documented.

Capacity Building

Experiences of NICRA project are to be disseminated to all concerned development departments for upscaling the interventions across the country. Capacity building on various resilient practices/ technologies, location specific mitigation and adaptation strategies, use of farm machinery, seed bank, fodder bank etc. are being taken up to enhance capacities of communities for better adoption of resilient practices. During the past six years, 10,130 capacity building programs have been organized benefiting 4.2 lakh stakeholders across the country.

Coordination, Monitoring & Review

Strategic, sponsored and competitive grants component of the scheme is being monitored by an Expert Committee with a Chairman and a panel of expert members representing different thematic areas and sectors to review the progress at various partner institutes. Technology Demonstration Component is reviewed by four Zonal Monitoring Committees (ZMC) with members from SAUs, ATARI, ICAR nominee etc. Besides this the High Level Monitoring Committee (HLMC) chaired by Secretary (DARE) and DG, ICAR with representatives from various ministries and line departments provides directions to the project.

Outputs

- Climate resilient technologies in terms of climate smart crop varieties, livestock breeds and management practices to bring climate resilience in agriculture.
- Improved preparedness for minimizing the impact of climate variability on Indian agricultural through site specific technology demonstration.
- Policy framework for promoting climate resilient agriculture, particularly among small and marginal farmers.
- Infrastructure at key research institutes for climatic change research.
- Adequately trained scientific man power to take up climate change research in the country.
- Empower farmers to cope with climate variability.

Outcome

- Enhanced resilience of agricultural production in vulnerable regions of the country.

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