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National innovations in climate resilient agriculture (NICRA): The reservoir of resilience enhancement

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Abstract

Climate change poses significant challenges for the agricultural sector, particularly in India, due to its large population, reliance on natural resources, and inadequate coping mechanisms. India has already experienced a temperature rise of 0.60°C in the past century, leading to negative impacts on crop yields and food security. To address this challenge, a scheme called Climate Resilient Agriculture (NICRA) has been introduced. NICRA aims to enhance the adaptability of Indian agriculture to climate change by creating and applying advanced technologies for production and the management of risks. The scheme focuses on strategic research, technology demonstration, capacity building, and sponsored research. Strategic research involves collaboration with 21 institutes to establish research infrastructure and address thematic areas. Technology demonstration involves presenting proven technologies in villages to help adapt agricultural and animal husbandry systems to the challenges posed by climate variability. The scheme's modules cover various aspects, including natural resource conservation, water management, crop production (drought-tolerant varieties, water-saving techniques), animal husbandry and fisheries management, and institutional interventions (seed and fodder banks, custom hiring centres, weather index-based insurance). Capacity-building initiatives train scientists in climate change research, while awareness programs target extension agents, policymakers, NGOs, and farmers. Expected outputs include the selection of climate-resilient crop genotypes and livestock breeds, demonstration of best practices in 100 vulnerable districts, strengthening of research infrastructure, and adequately trained scientific manpower. The ultimate goal of the scheme is to bolster the resilience of agricultural production in susceptible regions of India. The National Resource Management (NRM) Division of the Indian Council of Agricultural Research (ICAR) oversees the scheme's implementation, with the Central Research Institute for Dryland Agriculture (CRIDA) serving as the Lead Institute. In conclusion, the NICRA scheme is a vital government initiative aimed at strengthening the robustness of agriculture in India in the face of climate change. By focusing on research, technology demonstration, capacity building, and sponsored research, the program aims to address the challenges presented by changing climate patterns and ensure the enduring productivity of agriculture in vulnerable regions.

Keywords: Climate change, NICRA, resilience

Introduction

Climate change pertains to prolonged alterations in temperatures and atmospheric conditions over an extended period (UN, 2022). These shifts may be natural, such as through variations in the solar cycle. Since the 1800s, human actions have been the predominant factor in causing climate change, mainly stemming from the combustion of fossil fuels such as coal, oil, and gas. Climate variability, which is defined by the WMO (2022) as "variations in the mean state and other statistics of the climate on all temporal and spatial scales, beyond individual weather events." In simpler terms, variability is the range of climate compared to its average. The fluctuations comprising climate variability can influence patterns of rainfall, temperature and other variables on timescales anywhere from a few weeks to a few decades, and emissions continue to rise. As a result, the Earth is now about 1.1 °C warmer than it was in the late 1800s. The last decade (2011-2020) was the warmest on record (IRI, 2015).

Climate change and India

According to Byju's (2022) [2], information gathered from their website indicates that India is among the nation's most vulnerable to the effects of climate change. With one of the

highest concentrations of economic endeavours globally, it harbours a substantial population of impoverished individuals whose livelihoods hinge on natural resources, particularly relying heavily on rainfall. Anticipated consequences include heightened strain on India's water, air, soil, and forests, projected to be among the most severe globally.

The anticipated consequences of climate change are poised to significantly influence the daily lives of individuals in India, particularly concerning their water resources. While water is vital for sustaining life, it can also lead to destructive consequences, such as severe floods and prolonged droughts. In the context of a shifting climate, these unfavourable incidents are expected to intensify and occur more frequently, amplifying their impacts on communities and ecosystems.

Implications of climate change on agricultural systems

Changing precipitation patterns: Rainfall distributions have already started to alter throughout the nation, and these shifts are projected to amplify in the forthcoming years. This is likely to result in more concentrated episodes of intense rainfall and prolonged periods of dryness, even within specific regions. (Kulkarni *et al.,* 2020) [9].

Changing temperature patterns: Farmers in all regions are likely to be impacted by various changes in climate, such as increasing average temperatures, heightened occurrences of extreme heat throughout the year, a decrease in adequately cool days during winter, and a rise in the frequency of cold-season thaws (Karl *et al.,* 2009) [7].

Floods: Numerous agricultural regions across the country have already witnessed a rise in flooding, with coastal areas experiencing an amplified occurrence and severity of floods due to rising sea levels (Mirza, 2011) [32]. These destructive floods have substantial repercussions, including the devastation of crops and livestock, acceleration of soil erosion, water pollution, and the impairment of infrastructure such as roads, bridges, schools, and other facilities (Rahman, 2014) [25].

Droughts: Inadequate water supply can be as harmful as an excessive amount. Severe droughts have significantly impacted crops, livestock, and farmers in various country regions during the past decade. According to scientific findings, the increasing temperatures are expected to exacerbate these droughts, leading to further depletion of water supplies and, in certain instances, triggering destructive wildfires (Nath *et al*., 2017) [14].

Changes in crop and livestock viability: With the rapid shifts in local conditions expected in the upcoming decades, farmers will need to reassess their selection of crop varieties and animal breeds that are best adapted to their changing environments. Consequently, this may require them to make fresh capital investments, explore new markets, and acquire knowledge of alternative practices (Ickowicz *et al.,* 2012) [5].

New pests, pathogens, and weed problems: Just as farmers will need to find new crops, livestock, and practices, they will have to cope with new threats (UCS, 2019) [28].

Degraded soils: Climate change-induced soil degradation leads to reduced soil fertility, increased erosion, and altered microbial communities.

National adaptation fund on climate change (NAFCC)

In 2015-16, the Ministry of Environment, Forest, and Climate Change (MoEFCC) introduced the National Adaptation Fund for Climate Change (NAFCC) to address the needs of vulnerable sectors like Water, Agriculture and Animal Husbandry, Forestry, Ecosystems, and Biodiversity throughout the country. The main goal of the fund is to aid specific adaptation initiatives that are not addressed by the current programs of the State and National Governments. The purpose of these initiatives is to alleviate the negative impacts of climate change on communities, sectors, and states. The fund is structured to offer financial support for adaptation measures in regions that are especially vulnerable to the harmful effects of climate change (NAFCC, 2022).

The NAFCC is a pivotal instrument that emphasizes implementing tangible adaptation measures while encouraging state governments to incorporate a climate perspective into their planning processes. Within the NAFCC project in Kerala, approximately 250 coastal households will receive climate-resilient livelihood opportunities to improve their ability to cope with the effects of climate change (Prasad and Sud, 2019) [22].

Under the National Adaptation Fund for Climate Change (NAFCC), various ministries have implemented programs to address the challenges posed by climate change. The Ministry of Health & Family Welfare's National Vector Borne Disease Control Programme (NVBDCP) aims to lower the health-related burden caused by vector-borne diseases and extreme weather events. The Ministry of Rural Development's Neeranchal scheme focuses on managing water resources through the Integrated Watershed Management Program (IWMP) to address water-related challenges arising from climate change. The Ministry of Home Affairs has initiated the Coalition for Disaster Resilient Infrastructure (CDRI) to enhance the resilience of infrastructure systems to climate and disaster risks. Furthermore, the Ministry of Jal Sakthi's Jal Jeevan Mission aims to provide safe and sufficient drinking water to rural households through individual tap connections, overcoming groundwater depletion and unpredictable rainfall. Notably, separate projects have received approval for each state, including the Conservation and Management of Indigenous Varieties of Livestock project in Karnataka and the Promotion of Integrated Farming System of Kaipad in Coastal Wetlands project in Kerala, with approved budgets of ₹24.22 Crore and ₹25.00 Crore, respectively. In total, 30 projects have been sanctioned within the NAFCC, with a cumulative budget of ₹847 Crore (NAFCC, 2022).

National innovations on climate resilient agriculture (NICRA)

The National Innovations on Climate Resilient Agriculture (NICRA) is a collaborative project of the Indian Council of Agricultural Research (ICAR), initiated in February 2011 as part of the XI plan, with a budget of Rs. 650 crores. The primary objective of the initiative is to strengthen the capacity of Indian agriculture to withstand the impacts of climate change and associated vulnerabilities through

cutting-edge research and technology showcases. NICRA's research endeavours encompass strategies for adjustment and reduction in various sectors, including cultivation, animal husbandry, aquaculture, and the management of natural resources. The initiative comprises four elements: systematic research, technology exhibition, skill development, and sponsored/competitive subsidies. NICRA was formally launched on February 2, 2011 (AICRPDA, 2022) [1].

Objectives of NICRA

- Strengthening the adaptability of Indian agriculture, encompassing crops, livestock, and fisheries, to climatic fluctuations and climate change by advancing and implementing improved technologies for production and risk management.
- Showcasing tailored technology solutions on farmers' fields to address prevailing climate-related risks.
- Building the expertise of scientists and various stakeholders in research related to climate-resilient agriculture and its practical application (Suresh and Viswanathan, 2022) [27].

Unique facets of the scheme

- In-depth evaluation of various crops/zones across the country to assess their susceptibility to climatic stresses, extreme events, and intra-seasonal rainfall variability.
- Implementation of cutting-edge equipment, such as flux towers in extensive field areas, to measure greenhouse gases, enabling an understanding of the impact of management practices and contributing data on emissions.
- Swift and extensive screening of crop germplasm, including wild relatives, for drought and heat tolerance using phenomics platforms for the rapid identification of promising lines and early development and release of heat/drought-tolerant varieties.
- Comprehensive field assessment of innovative approaches to paddy cultivation, such as aerobic rice and SRI, to evaluate their potential contribution to reducing greenhouse gas emissions and enhancing water conservation.
- Particular emphasis is on the livestock and fisheries sectors, including aquaculture, which have historically received inadequate attention in climate change research. Specifically, documenting adaptive traits in indigenous breeds is considered a crucial step. [Rising temperatures trigger reproductive development in spring-spawning species, and decreasing temperatures stimulate reproduction in autumn-spawners (Pankhurst and Munday, 2011)] [33].
- In-depth exploration of the relationship between crops, pests, and pathogens, as well as the emergence of new biotypes due to climate change.
- Simultaneous expansion of the project's outcomes through Agricultural Science Centers (KVKs) and the National Mission on Sustainable Agriculture to encourage broader adoption by farmers.

Project components

The program will be executed through the following four components.

1. In-depth research strategically focused on adaptation and mitigation.
2. Demonstration of technology to address existing climate variability in districts susceptible to such changes.
3. Enhance capabilities through capacity-building initiatives.
4. Sponsored competitive research to address crucial gaps in knowledge (NICRA-ICAR, n.d.)

Strategic research

According to McMeekin *et al*. (2008) [10], Strategic Research refers to the type of research conducted with the anticipation of generating a wide-ranging knowledge foundation that is likely to serve as a basis for addressing identified or anticipated present or future issues or opportunities.

The strategic research element will engage 21 Institutes under the Indian Council of Agricultural Research. Notably, seven of these institutes, including CRIDA in Hyderabad, IARI in New Delhi, NDRI in Karnal, IIHR in Bangalore, CMFRI in Cochin, CIAE in Bhopal, and ICAR Complex for NEH in Barapani, will establish state-of-the-art research infrastructure. The remaining 14 institutes, such as CRRI in Cuttack, DRR in Hyderabad, NRCPB in New Delhi, IIVR in Varanasi, IIPR in Kanpur, ICAR-RCER in Ranchi, DWM in Bhubaneswar, NRCAF in Jhansi, PDFSR in Modipuram, NCIPM in New Delhi, IVRI in Izzatnagar, CIFRI in Barrackpore, CIBA in Chennai, and NIASM in Baramati, will contribute to strategic research in specific thematic areas that have been identified. Simultaneously, the initiative strives to showcase technologies capable of efficiently addressing the prevailing climate variability in 100 districts. This will be achieved through the participation of KVKs (Krishi Vigyan Kendras), Coordinating Centers of the AICRPDA (All India Coordinated Research Project on Dryland Agriculture), and the TOT (Transfer of Technology) Divisions of the core as mentioned above institutes. Additionally, most of the State Agricultural Universities will be involved through their KVKs and AICRP Centers in this particular initiative component (NICRA-ICAR, n.d.).

Regarding climate change and agriculture, the primary research themes include assessing the vulnerability of crucial production zones, offering agro-advisories based on weather patterns, evaluating primary food and horticultural crops for their resilience to climatic stresses and genetic enhancement, monitoring greenhouse gas (GHG) emissions through flux towers, and formulating adaptation strategies in livestock through nutritional and environmental interventions, adoption of adaptation and mitigation practices for water productivity, nutrient use efficiency, conservation agriculture, and agro-forestry systems, the study of pest and disease dynamics, and assessment of spawning behaviour of significant fish species to harness the beneficial effects of temperature changes. These research themes aim to deepen our comprehension of the impacts of climate change on agriculture. Additionally, they seek to formulate strategies to mitigate these effects, enhance resilience, and encourage adopting sustainable agricultural practices (Press Information Bureau, 2021) [24].

Technology demonstration

The demonstration method serves the purpose of validating the superiority of a new practice over the existing one, persuading and inspiring extension clients to try the new approach, and establishing a long-term teaching and learning environment (Khan, 2009) [8].

Within this specific component, the emphasis will be on showcasing an integrated package of proven technologies in a single village within each district. These demonstrations aim to illustrate how these technologies can be applied to adapt to and mitigate the impacts of climate fluctuations impacting both cultivation and animal husbandry systems. The selection of these technologies will be guided by their demonstrated effectiveness and appropriateness in addressing the challenges presented by climate variability.

Specific objectives of technology demonstration component

- To demonstrate site-specific technology interventions on farmers' fields.
- To generate awareness and build capacity of farmers and other stakeholders on climate resilient agriculture.
- To evolve innovative institutional mechanisms at the village level that enable the communities to respond to climate stresses (NICRA-ICAR, n.d.).

Selection of Districts

Districts are selected based on scientific analysis by CRIDA, Hyderabad, considering climate-related issues and farmers' experiences. The respective KVK in each district then selects one village or a cluster of villages for the demonstrations. The completion of the demonstration package includes analyzing climatic limitations, evaluating natural resources, identifying production systems, assessing institutional structures, and engaging in focus group discussions with the community to determine the necessary interventions. This process ensures a targeted and community-driven approach to adapting and mitigating climate variability in crop and livestock production systems (Venkateswarlu *et al.*, 2012) [30].

The interventions will cover the following four modules

Module I: Natural resources

This module comprises diverse interventions with a focus on in-situ moisture conservation, water harvesting, recycling for supplementary irrigation, enhanced drainage in flood-prone areas, conservation tillage, artificial groundwater recharge, and water-efficient irrigation methods. Among these interventions, the renovation and utilization of farm ponds were widely adopted, followed by the application of fertilizer based on soil tests (Pabba *et al.*, 2022) [19].

Module II: Crop Production

This module includes interventions such as introducing drought/temperature tolerant varieties, adjusting planting dates for rabi crops, implementing water-saving paddy cultivation methods, managing frost in horticulture, establishing community nurseries, setting up custom hiring centres, and promoting location-specific intercropping systems. Farmers have shown significant adoption of the medium-duration variety LRG-52 in red gram and the use of sticky traps in cotton to combat pests. Intercropping of cotton and red gram in a 6:1 ratio has also been observed. These interventions aim to address climate challenges and enhance agricultural productivity (Pabba *et al.*, 2022) [19].

Module III: Livestock and fisheries

This module centres on utilizing communal areas for fodder cultivation during periods of droughts and floods. It also involves implementing enhanced methods for the storage of fodder and feed. It also includes preventive vaccination for livestock, improving shelters to reduce heat stress, and managing fish ponds/tanks during water scarcity and excess water. The majority of farmers who own livestock have prioritized preventive vaccination to protect their animals from diseases, followed by deworming as a crucial practice. These interventions aim to ensure the well-being and health of livestock in challenging climatic conditions (Pabba *et al.*, 2022) [19].

Module IV: Institutional interventions

This module focuses on institutional interventions aimed at strengthening existing institutions or establishing new ones. These interventions include the establishment of seed banks, fodder banks, commodity groups, custom hiring centres, collective marketing initiatives, the introduction of weather index-based insurance, and the promotion of climate literacy through village-level weather stations. The utilization of Custom Hiring Centers (CHC) for timely field operations has been widely adopted, resulting in significant cost savings and enabling farmers to carry out field operations in a timely manner. Additionally, there has been partial adoption of village seed banks and fodder banks, demonstrating their potential value in supporting agricultural activities (Pabba *et al.*, 2022) [19].

Custom hiring centres

In each village, there is a Custom Hiring Centre (CHC), a Climate Risk Management Committee (CRRMC), and a Custom Hiring Management Committee (CHMC). These centres experience significant demand for equipment and implements. The selection and availability of implements are determined based on the needs and decisions made at the village level, with approval from the Village Climate Risk Management Committee (VCRMC). The implements are made accessible for hire at rates determined by the CHMC. The funds generated from the custom hiring services are utilized for the maintenance and repair of the implements, ensuring their continued functionality (Venkateswarlu *et al.*, 2012) [30].

Village-level seed bank

In order to address the issue of the availability of quality seeds, seed banks were established in NICRA villages with the purpose of providing farmers access to resilient crop varieties. Demonstrations of seed production were conducted in various NICRA villages for short-duration, drought-tolerant, and flood-tolerant crop varieties such as rice, wheat, soybean, mustard, chickpea, sorghum, gram, and foxtail millet. These initiatives significantly contributed to the adoption and spread of these varieties in the NICRA villages. The Village Climate Risk Management Committees (VCRMCs) played a crucial role in facilitating the activities of the seed banks within the NICRA villages (Venkateswarlu *et al.*, 2012) [30].

Fodder bank in NICRA Villages
To address the challenge of suitable fodder seed availability for delayed planting, a fodder bank was established in NICRA villages. The fodder bank contains high-yielding varieties of multi-cut pearl millet, sorghum, maize, hybrid Napier, lucerne, multi-cut baif, oat, and berseem. These varieties have superior nutritive value and enable year-round production of green fodder (Venkateswarlu *et al*., 2012) [30].

Agro-advisory services
Automatic weather stations were installed at NICRA KVKs, and mini-weather observatories were installed in NICRA villages for real-time weather monitoring. This data was utilized by KVKs to prepare agro-met advisories, and a total of 94 bulletins were issued for the NICRA village of Yagantipalle in Kurnool (Venkateswarlu *et al.*, 2012) [30].

Extension activities
NICRA KVKs conducted 1,859 extension activities during 2015-16, benefiting 19,067 practising farmers and farm women. These activities included method demonstrations, agro-advisory services, awareness camps, animal health camps, Krishak Chaupal, Kishan Gosthi, and more (Venkateswarlu *et al.*, 2012) [30].

Capacity building
As part of this component, scientists will receive training on the latest tools and methodologies of climate change research at renowned institutions worldwide. Additionally, senior faculty will undergo capacity building through short-term exposure visits and participation in international symposia. Training programs will also be organized for extension functionaries, policymakers, NGOs, and farmers to raise awareness about climate change. In 2015-16, a total of 1,042 programs were conducted, involving 32,219 participants, focusing on various aspects of climate change, adaptation strategies, natural resource management, efficient cultivars and cropping systems, livestock and fisheries, nutrient management, resource conservation technology, farm implements and machinery, feed and fodder management, vermicompost preparation, kitchen gardening, and enhancing nutritional security in NICRA villages (ICAR, 2022).

Sponsored research
Under this component, research proposals will be invited from identified institutions/ scientists to fill up critical research gaps (ICAR, 2022).

Extreme events
Village-level contingency plans for delayed onset/deficit rainfall conditions: Village-level contingency plans were created for drought-prone districts in 17 states. These plans include measures for delayed monsoon and deficit rainfall scenarios, such as demonstrating short-duration crop varieties and alternate crops. They also cover drought-proofing strategies, fodder production, and early rabi crop plans to compensate for production losses during the kharif season (Prasad *et al*., 2015) [23].

Response of NICRA-KVKs to extreme events
In Chittoor, NICRA KVK issued crop advisories to minimize crop damage caused by heavy rainfall. Recommendations included adjusting groundnut sowings, draining paddy fields, applying fertilizers, and spraying preventive solutions for disease control. In Matsyapuri, lodging-tolerant varieties were partially affected by heavy rains, and drainage and preventive sprays were recommended. High temperatures in Rajasthan, Western UP, Punjab, and Haryana affected wheat and mustard crops, but heat-tolerant varieties showed less damage. Unseasonal rains in Punjab and Haryana damaged some crops, but timely sown wheat with happy seeder and furrow irrigated raised bed planting for sugarcane showed better resilience (Prasad *et al*., 2015) [23].

Village level carbon balance studies
A carbon balance study was conducted in NICRA villages using the EX-ACT model to assess the impact of resilient practices on carbon emissions and sinks. The study covered 45 villages from 12 states and found that implementation of adaptation and mitigation measures resulted in a net carbon sink of -5413.25 t CO2 equivalents/year in nine arid region villages. The adoption of improved cultivars, fertilizer management, and efficient irrigation systems contributed to the maximum mitigation potential in arable systems. In Muttar village, Kerala, irrigated rice cultivation reduced crop residue burning and implemented organic matter addition, leading to mitigation (Prasad *et al*., 2015) [23].

Convergence with line departments
NICRA's implementation of KVKs established convergence with various development schemes and programs during the reporting year. This included IWMP, RKVY, NHM, NFSM, ATMA, MGNREGA, and several other schemes. The convergence brought synergies in planning, processes, and implementation. In the field of natural resource management, support was provided for water harvesting structures, micro irrigation systems, farm pond lining, and tree planting. In crop production, collaboration with line departments promoted the use of high-yielding varieties and cultivation practices like SRI and Direct Seeded Rice. Animal husbandry interventions focused on animal health, availability of medicines, and improved fodder crops. Capacity building of farmers through training and exposure visits was also part of the efforts. The aim was to enhance intervention coverage in villages through convergence with line departments (Prasad *et al*., 2015) [23].

Impact
The implementation of the NICRA project at Khagribari Village resulted in a significant reduction in migration, with a decrease of 90%. Additionally, farmers' income increased by up to 66.66% after the project's implementation. The survey data also indicated a positive change in housing conditions, with an increase in the percentage of respondents living in permanent houses ("pacca") from 4% before the project to 20% after the project. The majority of respondents still lived in traditional houses ("kacha"), but their proportion decreased to 80% after the project. These findings demonstrate the visible impact of the NICRA project on migration patterns, income levels, and housing improvements in Khagribari Village (Das and Rahman, 2018) [3].

Value addition involves economically enhancing a product by changing its characteristics or transforming it into a more desirable form. For example, training programs on value addition in pork, mushroom, and ginger were conducted by KVK Ri Bhoi, leading to the formation of two SHG units and increased income for farm women. Perishable products were previously sold at low prices, but value addition improved their economic status (Medhi *et al*., 2018) [11].

Factors such as education, social participation, landholding, innovativeness, mass media exposure, extension contacts, and attending training were found to have a positive and significant correlation with farmers' attitudes towards climate-resilient technologies (Pradhan *et al*., 2021) [21].

The implementation of the NICRA project has brought about significant changes in various aspects such as education, social participation, expenditure pattern, housing pattern, employment opportunities, occupation, material possession, annual savings, land possession, cropping pattern, income, and productivity of the beneficiaries (Mohokar *et al.*, 2019) [13].

Outputs

- Identifying and selecting cultivar genotypes and livestock breeds with enhanced tolerance to climatic stress.
- Showcasing best practices for climate resilience in 100 vulnerable districts.
- Enhancing infrastructure at key research institutes dedicated to climate change research.
- Providing training to scientific personnel for conducting climate change research in the country.
- Empowering farmers to effectively manage and adapt to climate variability. (ICAR, 2022).

Outcome: Improved agricultural production resilience in susceptible regions of the nation (ICAR, 2022).

Coordination and Monitoring

The implementation of the scheme will be overseen by CRIDA, Hyderabad, as the Lead Institute, under the overall supervision of ICAR's NRM Division. Monitoring committees were formed to assess the technical progress of various modules in NICRA villages, including NRM, crop production, livestock and fishery, and institutional intervention, and provide recommendations for enhancement (ICAR, 2022).

Application

The app Risk and Vulnerability Assessment of Indian Agriculture to Climate Change was developed by the Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad. The app enables users to extract information on climate change risk as well as on various components and indicators for the districts of choice. It is an Android-based app. The app's database has been designed using SQLite. The app helps in accessing information necessary for planning adaptation interventions and investments. It is also very useful for policymakers, researchers, and extension workers (VIACC - ICAR-CRIDA, 2022).

Conclusion

The Indian government continuously introduces new government programs to enhance the well-being of its citizens, addressing diverse issues and aiming to improve the economic, social, and cultural aspects of their lives. NICRA is a notable initiative that has made a substantial impact on the farming community at all levels. The NICRA project has played a crucial role in building climate resilience in agriculture, benefiting farmers and communities across the country. The project's holistic approach, encompassing research, technology transfer, capacity building, and convergence with other initiatives, has contributed to improved agricultural productivity, enhanced income, and sustainable livelihoods. Moving forward, it is important to build upon the success of NICRA and continue investing in climate-resilient agriculture to ensure a secure and sustainable future for India's agricultural sector in the face of climate change. It is crucial to continue implementing similar projects in the future for the overall benefit of the country.

References

1. AICRPDA [All India Coordinated Research Project for Dryland Agriculture]. [cited 2022 Oct 16]. Available from: http://aicrpda.in/aicrpda/attachments/282_AICRPDA-NICRA%20-TP-2020-21.pdf
2. Byjus. Climate Change In India: Background, Effects, Relevance and India's Response; c2022 [cited 2022 Oct 12]. Available from: https://byjus.com/free-ias-prep/climate-change-in-india-upsc-notes/
3. Das G, Rahman FH. Adoption and Discontinuation of Innovative Agricultural Technology by the Farmers of NICRA Village in Cooch Behar District. Religion. 2018;40:80.
4. ICAR. Title of the Brochure. [accessed 2022]. Available from: https://krishi.icar.gov.in/jspui/bitstream/123456789/22392/1/brochure.pdf
5. Ickowicz A, Ancey V, Corniaux C, Duteurtre G, Poccard Chapuis R, Touré I, *et al*. Crop-livestock production systems in the Sahel-Increasing resilience for adaptation to climate change and preserving food security. HAL; c2012.
6. International Research Institute for Climate and Society (IRI). Climate Variability. [accessed 2015]. Available from: https://iri.columbia.edu/our-expertise/climate/climate-variability/
7. Karl TR, Melillo JM, Peterson TC. Global climate change impacts in the United States: A state of knowledge report from the US Global Change Research Program. Cambridge University Press; c2009.
8. Khan A, Pervaiz U, Khan NM, Ahmad S, Nigar S. Effectiveness of demonstration plots as extension method adopted by AKRSP for agricultural technology dissemination in District Chitral. Sarhad J. Agric. 2009;25(2):313-319.
9. Kulkarni A, Sabin TP, Chowdary JS, Rao KK, Priya P, Gandhi N, *et al*. Precipitation changes in India. Assessment of Climate Change over the Indian Region:

A Report of the Ministry of Earth Sciences (MoES), Government of India; c2020. p. 47-72.
10. McMeekin T, Bowman J, McQuestin O, Mellefont L, Ross T, Tamplin M, *et al*. The future of predictive microbiology: strategic research, innovative applications and great expectations. Int. J Food Microbiol. 2008;128(1):2-9.
11. Medhi S, Islam M, Barua U, Sarma M, Das MG, Syiemlieh EC, *et al*. Impact of Climate Resilient Practices under NICRA Project in Ri Bhoi District of Meghalaya. Economic Affairs. 2018;63(3):653-664.
12. Ebcifa S, Judith Betsy C, Stephen Sampath Kumar J. Wastewater fish culture-way towards water reuse. Int. J Biol. Sci. 2022;4(2):112-116. DOI: 10.33545/26649926.2022.v4.i2b.87
13. Mohokar SD, Gohad VV, Ingawale PA, Holkar VV. Impact of national innovations on climate resilient agriculture (NICRA) project on beneficiaries. Agric Update. 2019;14(3):220-223.
14. Nath R, Nath D, Li Q, Chen W, Cui X. Impact of drought on agriculture in the Indo-Gangetic Plain, India. Advances in Atmospheric Sciences. 2017;34:335-346.
15. National Adaptation Fund on Climate Change – MoEF&CC. [cited 2022 Oct 14]. Available from: https://cckpindia.nic.in/national-adaptation-fund-on-climate-change/
16. NICRA-ICAR. National Innovations in Climate Resilient Agriculture (NICRA). [Accessed n.d.]. Available from: http://www.nicra-icar.in/nicrarevised/index.php/home1
17. NICRA-ICAR. Strategic Research. [Accessed n.d.]. Available from: http://nicra-icar.in/nicrarevised/index.php/strategic-research
18. NICRA-ICAR. Technology Demonstration. [Accessed n.d.]. Available from: http://www.nicra-icar.in/nicrarevised/index.php/technology-demonstration
19. Pabba AS, Naik R. Adoption of Climate Resilient Agricultural Technologies by Farmers in Nalgonda district of Telangana State. Indian J Ext Educ. 2022;58(2):30-34.
20. Paudel DP. Knowledge system of natural resource management in Andhikhola Gaunpalika, Syangja, District, Nepal. Int. J Geogr. Geol. Environ. 2020;2(2):04-10.
21. Pradhan S, Steffi P, Naberia S, Harikrishna YV. Assessment of Relationship between Profile Characteristics of NICRA Beneficiaries and their Attitude towards Climate-resilient Technologies. Int J of Environ. And Clim. Change; c2021. p. 444-447.
22. Prasad RS, Sud R. Implementing climate change adaptation: lessons from India's national adaptation fund on climate change (NAFCC). Clim. policy. 2019;19(3):354-366.
23. Prasad YG, Rao CS, Prasad JVNS, Rao KV, Ramana DBV, Gopinath KA, *et al*. Technology demonstrations-enhancing resilience and adaptive capacity of farmers to climate variability. Not Available; c2015.
24. Press Information Bureau. Government announces new measures to enhance economic growth. [accessed 2021]. Available from: https://pib.gov.in/pressreleaseiframepage.aspx?prid=1743354
25. Rahman SU. Impacts of flood on the lives and livelihoods of people in Bangladesh: A case study of a village in Manikganj district [Doctoral dissertation]. Brac University; c2014.
26. Su J, Ji W, Li H, Yao T, Wang J, Nan Z, *et al*. Zokor disturbances indicated positive soil microbial responses with carbon cycle and mineral encrustation in alpine grassland. Ecological Engineering. 2020;144:105702.
27. Suresh A, Viswanathan PK. Building climate resilience in Indian Farm households: An analysis of National and State Policies and Initiatives. Arab Economic and Business Journal. 2022;14(1):62-69.
28. UCS [Union of Concerned Scientists]. Climate Change and Agriculture. [accessed 2019]. Available at: https://www.ucsusa.org/resources/climate-change-and-agriculture
29. UN [United Nations]. What is climate change? [accessed 2022 Oct 8]. Available from: https://www.un.org/en/climatechange/what-is-climate-change
30. Venkateswarlu B, Kumar S, Dixit S, Rao Ch S, Kokate KD, Singh AK, *et al*. Demonstration of Climate Resilient Technologies on Farmers' Fields Action Plan for 100 Vulnerable Districts. Central Research Institute for Dryland Agriculture, Hyderabad; c2012.
31. VIACC - ICAR-CRIDA. [accessed 2022]. Retrieved from Google Play Store: https://play.google.com/store/apps/details?id=com.icar.crida.viacc&pli=1
32. Mirza MMQ. Climate change, flooding in South Asia and implications. Regional environmental change. 2011;11(Suppl 1):95-107.
33. Pankhurst NW, Munday PL. Effects of climate change on fish reproduction and early life history stages. Mar. and Freshw. Res. 2011;62(9):1015-1026.