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## Building climate resilience in Indian Farm households: An analysis of National and State Policies and Initiatives

A. Suresh

*Amrita School of Business, Amrita Vishwa Vidyapeetham Amritapuri, Kollam, Kerala, India, suresh@am.amrita.edu*

P. K. Viswanathan

*Amrita School of Business, Amrita Vishwa Vidyapeetham Amritapuri, Kollam, Kerala, India, viswanathanpk@am.amrita.edu*

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## REVIEW ARTICLE

# Building Climate Resilience in Indian Farm Households: An Analysis of National and State Policies and Initiatives

A. Suresh, P.K. Viswanathan\*

Amrita School of Business, Amrita Vishwa Vidyapeetham, Amritapuri, Kollam, Kerala, India

### Abstract

Over the years, the wrath of the nature in the form of adverse changes in the climate is borne by the agriculture sector all over the world, threatening the global food security. Indian agriculture is highly vulnerable to climatic extremes as agriculture forms the mainstay of the rural population. With increasing adverse effects caused by the climatic extremes, India has also embarked on various initiatives towards making its agriculture sector resilient to the vagaries of nature. In this regard, this paper reviews the studies related to climate change and its impact on Indian agriculture followed by the climate resilient agriculture adaptation practices across states as informed by a critical review of studies. The paper then examines the status in the allocation of resources by the national government under the National initiatives on Climate Resilient Agriculture (NICRA) across states. It was observed that there is dearth of adequate financial investments amongst states which are highly vulnerable to climate change risks. The resources allocation seems to be mainly concentrated among 6–10 states, leaving the rest of the country fund-starved. Also, there is a gap in the funds released under the NICRA and the expenditure made by the states for undertaking various climate resilient agriculture activities in terms of adaptation and mitigation leading to sustainable agriculture development outcomes. The paper brings out the imperatives for proper diffusion of technologies to enhance resilience to climate change in all the vulnerable regions and states. Timely interventions are also called for, by the national and state governments through providing financial support to the farmers in accessing the latest technologies available, to build resilience.

*Keywords:* Climate resilience, National initiatives, Climate resilient agriculture, National mission for sustainable agriculture, National innovations on climate resilient agriculture

## 1. Introduction

Climate change has serious repercussions on the agriculture sector all over the globe, especially in developing countries like India where a major chunk of population is heavily dependent on the primary sector, thereby increasing the need for developing appropriate coping strategies for poor farming communities. As evidences suggest, the frequency of the occurrence of extreme climatic events, especially droughts have been adversely affecting agricultural production and productivity in most parts of India, impacting the farm livelihoods.

The impact of climate change consists of direct and indirect effects on crop yields, water, soil, pests and so on. It is projected that the changes in climate would reduce the yields of irrigated and rainfed rice by 4% and 6% ([www.nicra.iari.res.in](http://www.nicra.iari.res.in)). Likewise, the yields of other food crops like wheat, maize and others are also projected to decline in the coming years. The indirect impacts of climate change on agriculture arise mainly due to factors like non-availability of water for irrigation, increasing frequency and intensity of inter and intra seasonal droughts and floods, changes in the pest profiles, decline in arable areas due to submergence of

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\* Corresponding author.  
E-mail address: [pkviswam@gmail.com](mailto:pkviswam@gmail.com) (P.K. Viswanathan).

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coastal land and availability of energy ([www.nicra.iari.res.in](http://www.nicra.iari.res.in)).

Nearly 50 billion tons of carbon dioxide is being emitted globally and India's contribution was 5% of the global emissions. In India, 65% of the GHG emissions are from the energy sector followed by agriculture (18%) and industry (16%). The GHG emissions from the Indian agriculture has increased by 80% from 1970 to 2014 mainly due to the increase in the livestock population, increased use of fertilizers and other agricultural inputs. Agriculture sector, thus is both the culprit and victim of climate change ([www.nicra.iari.res.in](http://www.nicra.iari.res.in)).

Therefore, it is critical to make the Indian agriculture more resilient to climate change in terms of adaptability, mitigation and sustainability so that agriculture productivity is increased, and food security is ensured. It has been observed that both implementation of advanced technologies and appropriate policies may help the agriculture sector become more resilient. Incidentally, there also exists ample traditional wisdom and proven practices amongst the farmers to manage the climate variations, which are not widely appreciated in the existing agriculture development strategies in the country. It is also important to note that the numerous abiotic stresses experienced affect the crop production and livestock management in the form of water shortage, degradation of land and loss of agri-biodiversity. This makes it imperative to have a determined policy and agriculture development strategy for India which should be adequately strengthened by fundamental and empirical research and practices across states and regions in the country. Such an agriculture development strategy should also integrate the critical component of climate resilience 'by way of using the technology and knowledge that the farmers already practice in their fields as an all-inclusive bundle'.

### *1.1. Climate resilient agriculture: macro policies and initiatives*

The Indian Council of Agricultural Research (ICAR), with the support of Ministry of Agriculture launched the National Innovations on Climate Resilient Agriculture (NICRA) in February 2011 with the aim of enhancing the resilience of Indian agriculture which is highly vulnerable to climate change by developing improved technologies through research. NICRA mainly focuses on demonstration of technology, capacity building, strategic research and providing sponsored or competitive grants.

Among the three, strategic research is emphasized across all segments of dairying, fisheries and

agriculture, especially, a concurrent valuation of the effect of climate change with preparation of adaptive coping strategies. Developing technologies for climate resilient agriculture becomes important to enhance farm production and productivity, taking into consideration of the natural resources that are also scanty and highly varying in quality and quantity across regions. The four tenets of NICRA that are targeted towards making the farmers more self-reliant include improving: (a) the soil condition, (b) crop production, (c) natural resource management, and (d) livestock. The important objectives of NICRA are to augment the flexibility of agriculture including livestock and fisheries to climatic unpredictability and change through application and development of better-quality management of risk and production technologies ([www.nicra-icar.in](http://www.nicra-icar.in)). It also emphasizes on launching site-specific technology packages on farmers' fields for addressing the climate risks and to improve the capacity of the scientists and all other relevant stakeholders in the programme.

The NICRA also stresses on providing greater tolerance to climatic stresses and covers an assortment of promising crop genotypes and livestock. The programme also incorporates the current best practices for climate resilience established in 100 vulnerable districts, while also reinforcing the need for infrastructure development at important research institutes with adequate scientific manpower for monitoring climatic change scenarios across field conditions.

### *1.2. Objectives, data and methods*

In this backdrop, this paper tries to assess the national initiative on climate resilient agriculture (NICRA) launched in India in 2011. In section 2, the paper presents a comprehensive review of the literature on climate change impacts on agriculture in India. It then attempts a state level comparative analysis of the funds allocated under the NICRA project over the years in section 3. Based on the emerging trends, we also discuss the major findings based on the study and come out with some plausible policy suggestions that would help scale up the best management practices. The section then discusses the major findings based on the analysis of four years' data from 2010–11 to 2014–15 on the state level allocation of funds for the programme. Section 4 concludes the paper with some observations on the policy and practical level implications of the programme. The paper is based on secondary data collected from IndiaStat database, which provides the funds allocated across various states.

Simple analysis has been done using the available data, to identify the states receiving highest funds for NICRA and highlight the divergence in climate resilient agriculture interventions. As the NICRA was introduced only few years back, a serious analysis could not be attempted due to paucity of time-series data across states and programme activities.

## 2. Climate resilient agriculture in India: A review of studies

At the outset, it may be observed that the concept of climate resilient agriculture (CRA) is at its nascent stage with the ideas and practices yet evolving. There can be wide differences between fast developing countries like India and the developed countries in terms of CRA practices, which is not discussed in this paper. So far as Indian agriculture is concerned, many studies could be traced that discusses the linkage between climate change impacts and agriculture performance across states. In that count, there has been exponential growth in the literature focusing on climate change events and their interface with agriculture. It is important to understand that even though the term 'climate smart agriculture' was coined in the recent past, the impacts of the adverse climatic conditions are being addressed and the efforts in the direction of adaptation and mitigation of the adverse impacts of climate change began long back. Arid and Semi-arid regions in India are adversely affected by climate change and the loss will be higher if suitable adaptation measures are not adopted. [Grover and Upadhyaya \(2014\)](#) revealed that some regions in Punjab had significant increase in the average minimum temperature ranging from 1.4 to 2.1 °C during all months in Kharif season. [Birthal et al. \(2014\)](#) found that rise in temperature in Kharif as well as Rabi seasons have harmful effects on agricultural productivity. Higher rainfall, unless it is in excess, has a beneficial effect, but the effect is too small to offset the negative effect of temperature. Water logging and soil salinity are yet other problems that hinder agricultural production in India. This is a serious threat as the groundwater in many of the endangered regions have become brackish and saline due to the rising water table ([Datta et al., 2004](#)). Reduction in the rainfall puts a lot of stress on the ground water resources especially in states like Punjab where agriculture is highly dependent on the groundwater sources ([Kaur, 2011](#)).

Agriculture in India is highly vulnerable to natural disasters mostly associated with irregularities in the rainfall pattern, causing mainly flood and droughts.

[Arora and Birwal \(2017\)](#) evaluated the economic impact of these natural calamities on farmers in Odisha in terms of crop loss. The results indicated that the total loss to the farmer increases with their land sizes, while per acre losses incurred are more for small farmers as the large farmers can overcome the stresses with the help of coping strategies like crop insurance, short duration crops and access to institutional credit. It is widely accepted that adoption of appropriate coping strategies can reduce the intensity of the impact of changing climatic conditions on agriculture. A wide variety of practices are being adopted in different parts of the world with the motive of adapting to or mitigating the adverse impacts of climate change. Many of the traditional agricultural practices like agroforestry, crop rotation, organic composting, integrated crop and animal husbandry proves to be extremely climate resilient ([Singh, and Singh, 2017](#)).

Adaptation practices are undertaken ex-ante and ex-post the adverse impact. Some of the ex-ante adaptation strategies mainly adopted in India include mixed farming, crop diversification, varietal adjustments, adjustment of planting dates etc ([Begam and Mahanta, 2017](#); [Suresh et al., 2017](#)). The measures adopted to alleviate the adversities of climate change in agriculture include water management strategies, technological and institutional interventions.

A set of climate change related studies focused on water management strategies to tackle the issues associated with climate change in agriculture. It is observed that due to over exploitation of the ground water resources for irrigation, in states like Maharashtra and Gujarat, micro irrigation is majorly promoted as an adaptation strategy by the state and central government through providing subsidy ([Singh, 2013](#); [Suresh et al., 2017](#); [Bahinipati & Viswanathan, 2019](#)). There are several factors determining the adoption of the various climate resilient practices. For instance, crop insurance is not considered as a useful precaution rather an additional expenditure and this lack of awareness among the farmers acts as a major constraint in the diffusion of crop insurance schemes ([Suresh et al., 2017](#)).

Technological and institutional interventions are also crucial for designing a more responsive climate resilient agriculture system by protecting and enhancing the livelihood opportunities of the farmers. In this regard, [Sidhu, et al. \(2011\)](#) revealed that developing capacities in climate forecasting and decision tools are imperative to guide irrigation scheduling, application of fertilisers and crop choice decisions. Using technologies like tensiometers, laser leveling and direct seeding of rice to improve

irrigation water use efficiency can promote climate resilience. However, due to the lack of knowledge about the technology, low capacity and lack of access to credit prohibit farmers from adopting such climate resilient technologies. Viswanathan et al. (2020) presents a comprehensive assessment of the global trends in research on climate resilient agriculture.

There is a growing concern regarding climate change and its adverse impact on agriculture, which pushes the governments at the national and State levels to adopt policies and practices that can reduce the intensity of the climate change impacts. Notably, some of the State governments are becoming more proactive in reducing the adverse effects of climate change on agriculture. For instance, Government of Maharashtra undertook the Project on Climate Resilient Agriculture in partnership with World Bank with the objective of enhancing climate-resilience and profitability of smallholder farming systems in selected districts of the state. It is found that poverty is mainly concentrated in the rainfed regions in Maharashtra. The project aims to make 5000 villages free from water scarcity every year by concentrating on the vulnerable regions of Marathwada and Vidarbha. Similarly, the projects like Harnessing Opportunities for Productivity Enhancement of Dry Land Cereals (HOPE) project by the International Crops Research Institute for

Semi-Arid Tropics (ICRISAT) encourages the integrated farming system in Semi-Arid Tropic states of Rajasthan, Gujarat, Haryana and Maharashtra. For instance, while time tested crop-livestock combination was practiced in Maharashtra, pearl millet-buffaloes combination is promoted in Gujarat, Rajasthan and Haryana. More than 75 percent of the farmers benefitted by bridging the productivity gap and thereby enhancing the income in both crop and livestock sectors (Nagaraj et al., 2013).

Table 1 presents a synoptic view of the literature on climate resilient agriculture, which broadly discusses the some of the relevant studies undertaken by various scholars during the period between 2004 and 2020 relating to the important aspects, such as: (a) vulnerability of regions and communities; (b) impact of climate change on agriculture performance; (c) technological interventions; (d) water management strategies; (e) institutional interventions; (f) mitigation strategies; and (g) sustainability.

### 3. Climate resilient agriculture: national and state policies and initiatives

The Government of India initiated the mega project, called National Initiatives on Climate Research Agriculture (NICRA) with a budget of (US \$ 44

Table 1. Literature related to climate resilient agriculture in India.

Area of focus	State/ Region	Researchers
1. Vulnerability and determinants of adaptation	Jharkhand	Hiremath and Shiyani (2013), Das and Barman (2010), Vatta et al. (2017)
2. Impact of climate change in agriculture	Rajasthan, Ludhiana, Andhra Pradesh Maharashtra	Nongbri et al.(2016), Birthal et al. (2014), Mohan (2012), Grover and Upadhyya (2014), Kumar et al. (2011), Jha &Tripathi (2011), Kaur (2011), Datta et al. (2004).
3. Technological interventions	Uttar Pradesh, Andhra Pradesh, Tamilnadu	Kaarthikeyan & Suresh, (2019), Bhardwaj et al., 2018, Singh et al. (2018), Rao et al. (2017), Devi et al. (2015), Nagaraj et al. (2013), Thennarasu and Banumathy (2011), Sidhu et al. (2010), Singh et al. (2010), Aggarwal and Singh (2007), Laxmi and Mishra (2007).
4. Water management strategies	Punjab	Chandrakanth et al. (2013), Jana et al. (2012), Sidhu et al. (2011), Narayanamoorthy (2010), Kumar and Palanisami (2009), Narayanamoorthy (2005), Reddy et al.(2005), Shaheen and Shiyani (2005), Sharma and Sharma (2004), Singh (2004).
5. Other measures	Assam	Begum and Mahanta (2017), Suresh et al. (2017), Mandal and Bezbaruah (2013), Kumar et al. (2012), Angles et al. (2011), Thimmappa and Mahesh (2006), Sharma (2005).
6. Institutional interventions	Andhra Pradesh Semi-Arid States (Rajasthan, Gujarat, Haryana, Maharashtra)	Rao et al. (2017) Nagaraj et al. (2013)
7. Mitigation strategies	Odisha	Arora and Birwal (2017), Karoshi and Nadagoudar (2012), Singh (2009)
8. Sustainability	Kerala	Devi et al. (2015) Kumar (2013), Chand and Sirohi (2012), Tewari (2005), Thakur and Sharma (2005), Kshirsagar (2008)

Source: Authors' compilation based on literature review.



million) during the year 2010–11 and the National Mission for Sustainable Agriculture (NMSA) scheme with a budget support of (ie., US\$ 23478 million) in order to improve resilience of agriculture with development of cultivars as one of the main components. Highlighting the necessity for research in agriculture particularly under the changing climate scenario a third issue on the status of Agricultural R&D investment in India was deliberated and exposed that the Agricultural Research Indicator (ARI) level is far below the suggested level of 2%, being only 0.43% during 2012–13.

In order to meet the need of the farming community together with the objectives of the stated Government initiatives and the mark set to attain 2% of ARI during the twelve plan, it was suggested that the Agricultural R&D investment must be reinforced to uphold the viability of Indian agriculture (Rymbai et al., 2016). While there are options of developing climate-resilient crops, with more focus on research and development especially pioneered by the private sector seed corporations, there are apprehensions about this necessitating the role of the state in spearheading the climate resilient agriculture development strategies (Saab, 2016).

### 3.1. Climate resilient agriculture: trends in financial allocations

The data on allocation of funds to different states under NICRA reveals that there is significant variations in the amount of funds sanctioned and expenditure incurred across states (Table 2). Delhi and Andhra Pradesh top the list of states with highest allocation of funds for NICRA followed by

Karnataka, Haryana, Uttarakhand, Kerala, Odisha, Maharashtra, Madhya Pradesh and Meghalaya.

The 15 states listed in the Table receive almost 83% of the total funds allocated in the country for various actions envisaged under the climate resilient agriculture initiative. Apparently, these states also seen to be consistent in implementing the climate resilient agriculture activities by effectively utilizing the funds released by the national government. Notably, rest of the states, including the Northeastern states and states like Chhattisgarh are not being provided enough funds despite the fact that the north eastern states are more vulnerable to the adverse impacts of climate change as there exists a large segment of marginalized communities, including tribals, whose main source of livelihood is agriculture. Also, the agriculture sector in states like Assam are frequented by extreme events like floods which results in loss of food production.

It is also observed that there are differences in the amount of fund sanctioned for NICRA and the expenditure made for NICRA (Fig. 1). Though most of the states were provided with funds during the period 2012–13 to 2014–15, the governments seem to have not fully utilised the funds for undertaking activities to enhance resilience in agriculture. However, it is seen that in Bihar, only 68% of the funds sanctioned have been released for CRA activities but the state has made an expenditure which exceeded the sanctioned amount.

Southern states like Kerala, Tamilnadu, Karnataka, Andhra Pradesh and the North Eastern states have completely utilised the sanctioned funds for NICRA activities even though the funds sanctioned by the National government to these states are

Table 2. Top 15 states with highest allocation of funds under NICRA (2010–15) [INR. Million].

#	States	2010–11	2011–12	2012–13	2013–14	2014–15	Cumulative	(%)
1	Andhra Pradesh	466.80	166.40	109.10	93.00	87.20	922.50	19.32
2	Delhi	325.00	225.40	139.20	129.90	96.60	916.10	19.19
3	Karnataka	210.00	88.70	69.30	39.80	41.80	449.60	9.42
4	Haryana	150.50	52.60	36.10	48.20	36.40	323.80	6.78
5	Uttarakhand	115.80	87.70	46.60	35.80	30.90	316.80	6.64
6	Kerala	74.50	49.10	50.30	25.90	25.60	225.40	4.72
7	Odisha	48.80	107.00	25.80	22.10	16.60	220.30	4.62
8	Maharashtra	126.70	24.60	22.20	15.30	19.20	208.00	4.36
9	Madhya Pradesh	76.60	61.30	22.40	20.50	11.40	192.20	4.03
10	Meghalaya	6.60	5.90	52.80	51.40	38.10	154.80	3.24
11	West Bengal	35.90	27.80	21.10	18.40	11.40	114.60	2.40
12	Tamil Nadu	24.80	2.70	34.90	32.20	12.70	107.30	2.25
13	Bihar	27.50	26.30	27.60	17.40	8.50	107.30	2.25
14	Punjab	12.60	43.50	8.50	10.20	6.10	80.90	1.70
15	Rajasthan	37.60	5.20	16.50	9.30	7.00	75.60	1.58
	Sub-total (15 states)	1740.00	974.30	682.30	569.50	449.10	4415.20	92.49
	Rest of Indian states	106.20	92.20	77.20	42.30	40.60	358.50	7.51
	All India	1846.21	1066.52	759.52	611.83	489.63	4773.71	100.00

Note: The value of INR against US\$ was INR 46 per 1 USD in 2010.

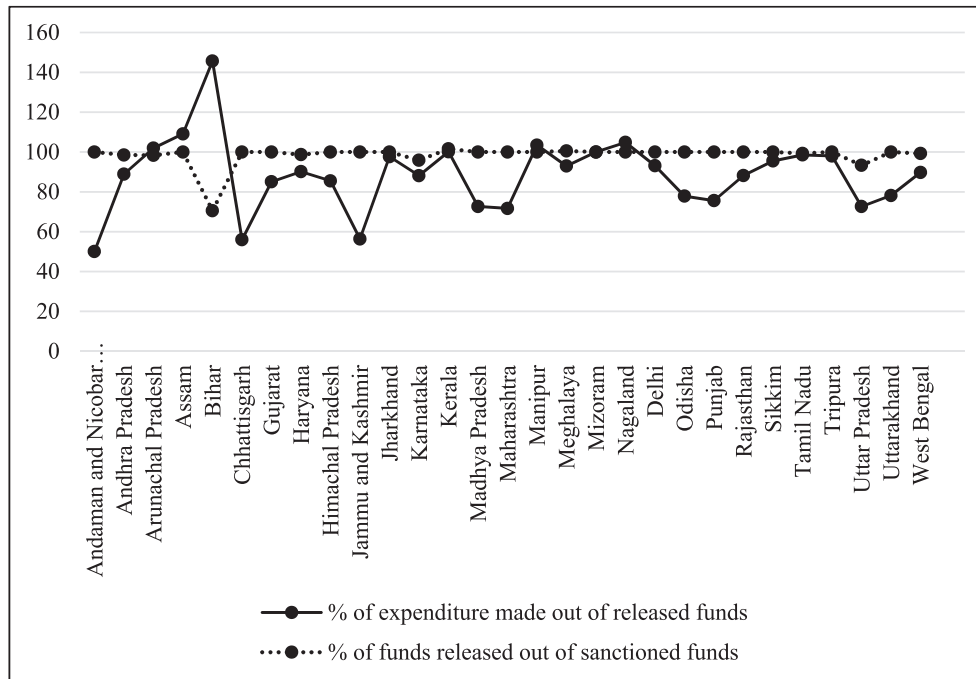


Fig. 1. Funds released and expenditure made on NICRA during 2012–13 and 2014–15. Source: Estimated by authors based on Indiatat data ([www.indiatat.com](http://www.indiatat.com)).

insufficient to cover up their vulnerability to climate change. Therefore, it is imperative that more funds are allocated for states, like Tamil Nadu where, most part of the state suffer from increased drought conditions, thus affecting the income and livelihoods of the farmers.

#### 4. Conclusions and policy imperatives

In the emerging context of revamping global agriculture towards 'climate resilience', India also had launched various climate resilient agriculture (CRA) initiatives. This paper examines the status of adoption of CRA interventions across states. It highlights that India's efforts in this direction are commendable with several states seriously engaged to address the climate change induced risks confronting agriculture development. Nevertheless, the fact remains that the programme is of recent origin and it requires some more time to come to terms with the real impacts of the initiative across the states. The analysis of the expenditure pattern across states for the brief period 2010–11 to 2014–15 reveals that many of the states are yet to realize the importance of climate resilient agriculture practices and respond to the same by allocating financial resources sourced from within besides utilizing the centrally allocated funds. While it is important to attract the funds earmarked by the national government to allocate for the activities undertaken for

climate resilient agriculture, the state governments also need to adopt policy measures and proactive strategies for addressing the issues faced by them.

It also seems that the current level of allocation and expenditure on the activities are highly skewed towards handful of states, which is not a welcome scenario. Given that livestock related activities are also seriously affected by the climate change risks, it becomes important to have a proper livestock breeds selection and promotion of promising crop genotypes genotypes which will have more tolerance to climatic stress across regions. Thus, it ultimately results in making the farmers resilient to cope up with climate vulnerability. The literature survey attempted in the paper highlights the dearth of studies based on micro level evidences on the diversity of climate resilient agriculture practices, technological diffusion and coping mechanisms adopted by farming communities across agro-climatic and ecologically fragile and marginal environments.

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