



AgEcon SEARCH

RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

Mainstreaming Climate Change Adaptation into Development Planning

Naveen P Singh
Arathy Ashok
Pavithra S
Balaji S J
Bhawna Anand
Mohd Arshad Khan



भा.कृ.अ.प.- राष्ट्रीय कृषि आर्थिकी एवम् नीति अनुसंधान संस्थान

ICAR – NATIONAL INSTITUTE OF AGRICULTURAL ECONOMICS AND POLICY RESEARCH

NIAP Publication Committee

Suresh Pal
P S Birthal
Naveen P Singh
Shiv Kumar
Raka Saxena

National Institute of Agricultural Economics and Policy Research (NIAP) was established by the Indian Council of Agricultural Research (ICAR) to strengthen agricultural economics and policy research in the National Agricultural Research System comprising network of ICAR institutions and State Agricultural Universities. The mandate of the Institute is:

- Agricultural economics and policy research on markets, trade and institutions
- Growth and development models for sustainable agriculture
- Technology policy, evaluation and impact assessment

NIAP has emerged as a think tank in the area of agricultural policy and it has contributed to increased participation of ICAR in policy making. Besides ICAR, the Institute regularly provides research based input to NITI Aayog, Government Departments, States and other stakeholders for policy decisions in diverse areas related to agriculture.

Mainstreaming Climate Change Adaptation into Development Planning

Naveen P Singh
Arathy Ashok
Pavithra S
Balaji S J
Bhawna Anand
Mohd Arshad Khan



Singh, Naveen P., Arathy Ashok, Pavithra S., Balaji S.J., Bhawna Anand and Mohd. Arshad Khan. (2017). *Mainstreaming Climate Change Adaptation into Development Planning*. Policy Paper 32. ICAR-National Institute of Agricultural Economics and Policy Research (NIAP), New Delhi.

Published by

Dr Suresh Pal

Director

ICAR – National Institute of Agricultural Economics and Policy Research
New Delhi - 110 012

© 2017, National Institute of Agricultural Economics and Policy Research

Published

November, 2017

The views expressed in this policy paper are those of the authors and do not necessarily reflect the official policy or position of NIAP or ICAR.

Printed at

National Printers, B-56, Naraina Industrial Area, Phase II, New Delhi-110028;
Phone No.: 011-42138030, 09811220790

Foreword

Agriculture is an important economic activity, providing livelihood to millions of farmers and other workers in the country. Performance of the agricultural sector is crucial, considering its role in income generation, poverty reduction as well as in ensuring food security to ever-growing population of the country which is projected to reach 1.5 billion by 2030. Today the challenge before agriculture is not just about producing enough food to meet the growing demand of the population but sustainability of the system. The sector faces multitude of challenges including the issues of low productivity, degrading resource base, rising cost of production and changing climatic conditions.

Climate change is one of the key factors influencing the performance of agriculture given that majority of cultivated land in the country is under rainfed conditions. Changing temperature and rainfall patterns have a drastic effect on agricultural production, affecting the livelihoods of millions of people depending directly or indirectly on agriculture. Climatic variability increases production risks and deters adoption of improved technology. It is high time to emphasize on the adaptation and mitigation strategies among farming communities in order to combat the deleterious effects of climate change.

A number of research initiatives have been taken up to address climate change issues in agriculture, yet field level challenges in terms of lack of awareness among the farmers, and barriers to adoption of suitable technology for mitigating and adapting to changing climate are major concerns. Mainstreaming of climate change adaptation strategies with the existing development activities offers potential ways to strengthen the response strategy of farmers to the changing climate. The present policy paper aims at developing a framework and highlighting the opportunities for the same based on field surveys and an extensive review of various ongoing development activities for mainstreaming climate adaptation planning into agricultural development.

Suresh Pal
Director

Acknowledgments

We thank the ICAR–Central Research Institute for Dryland Agriculture (CRIDA) for entrusting us the project on **“Mainstreaming Adaptation Policies in Development Planning to Enhance Resilience of Indian Agriculture”** under the National Innovations on Climate Resilient Agriculture (NICRA) Network Project.

Our sincere thanks are due to Dr Ch Srinvasa Rao, former Director, CRIDA and Dr M Prabhakar, Principal Investigator, NICRA, CRIDA for the support extended during the course of this work. We thankfully acknowledge the help and support extended by Dr Rajbir Singh, Director, ATARI, Ludhiana and KVK team at Moga, Punjab; Dr V U M Rao, former Project Coordinator-ACRIPAM; Dr K V Rao, Principal Scientist-SWM; Dr Rama Rao, Head, Section of Design and Analysis, ICAR-CRIDA and his colleagues during the field level survey in Telangana.

We thank Dr Suresh Pal, Director, ICAR-NIAP for his constant support and encouragement extended for this project. We extend our heartfelt thanks to our former Acting Directors, Dr Usha R Ahuja and Dr P S Birthal, for their support and technical guidance towards this study. We also thank staff from the finance and administration section of ICAR-NIAP for their support and co-operation.

We are grateful to the NIAP Publication Committee and learned referees for their insightful comments and observations on the manuscript. Last, but not the least, we would like to express our sincere gratitude to all the individuals who have directly or indirectly helped us during the study.

We hope that the policy paper will serve as a significant source of information to all the agencies and organizations involved in designing and implementing adaptation strategies for enhancing resilience of agriculture to climate change.

Authors

Contents

<i>Foreword</i>	iii
<i>Acknowledgements</i>	v
<i>Acronyms and Abbreviations</i>	ix
<i>List of Tables and Figures</i>	xi
<i>Executive Summary</i>	xiii
1. Introduction	1
1.1 Climate Change Adaptation in Agriculture	1
1.2 Why Mainstreaming Adaptation into Development?	2
1.3 Data and Methodology	3
2. Micro-level Perceptions of Climate Change and Adaptation	5
2.1 Farmers' Perceptions on Climate Change Impacts	5
2.2 Farm and Household Level Adaptation Strategies	7
2.3 Barriers to Climate Change Adaptation	8
3. Mainstreaming Climate Change Adaptation into Development Planning	11
3.1 Thematic Areas for Mainstreaming Climate Change Adaptation Planning	11
3.2 Budgetary Allocations for Programmes under Identified Thematic Areas	13
3.3 Need-Based Adaptation Planning: Aligning Micro-level Issues and Macro-level Interventions	16
4. Conclusions and Policy Implications	23
References	25
<i>Annexure</i>	29

Acronyms and Abbreviations

ICAR	Indian Council of Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IPCC	Intergovernmental Panel on Climate Change
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MoA&FW	Ministry of Agriculture and Farmers' Welfare
NAPCC	National Action Plan on Climate Change
NICRA	National Innovations on Climate Resilient Agriculture
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

List of Tables and Figures

Tables

Table 1:	Study locale and sampling details	4
Table 2:	Comparative budgetary allocation across the identified critical domains	14
Table 3:	Budgetary allocations on different sub-groups under the critical domains	15
Table 4:	Issues and plausible options for mainstreaming climate change adaptation planning with existing development programmes	17
	(a) Grass-root constraints and options for potential adaptation strategies	17
	(b) Climate change impacts perceived by the farmers	18

Figures

Figure 1:	Farmers' perceptions on climatic and non-climatic impacts	5
Figure 2:	Farmers' perceptions on socio-economic impacts of climate change	6
Figure 3:	Strategies adopted by farmers in response to climate changes	8
Figure 4:	Farmers' response on potential barriers to climate change adaptation	9
Figure 5:	Critical domains and sub-groups of rural development for integrating climate adaptation planning	12

Executive Summary

Climate change poses serious threats to the food security and sustainability of livelihood across diverse ecosystems. Scientific research has well established that climate change has significant adverse impacts on many economic sectors, agriculture being the worst hit. Though adaptation to various risks has been a continuous process, climate change adaptation has become significant in the short and medium term. Several studies have emphasized that climate adaptation strategies cannot be isolated and they need to be a part of the regular development activities in the mode of a '*Development Continuum*'. The magnitude of the need for adaptation and the potential for mitigation in agricultural development has major implications for successful agricultural development planning to support food security and poverty reduction.

This paper attempts to mainstream the climate change adaptation planning with the on-going development programmes. The cues for adaptation planning, which explored the major impacts of climate change as perceived by the farmers, and coping strategies adopted at farm household level, were obtained from the primary survey, conducted in the selected states, namely Punjab and Telangana. This work facilitates proper adaptation planning at the national level for sustainable agriculture and informed adaptation decision making among the vulnerable farmers. *Even though a large number of programmes or schemes are being implemented for agriculture, farmers' welfare and rural development, they often lack a plan for encouraging climate change adaptation actions and are scattered across different ministries/departments.* An attempt has been made to develop a framework for mainstreaming climate change adaptation planning in developmental landscape.

Different agriculture and rural developmental programmes implemented across various ministries were compiled and their budgetary allocations over a time period are analysed for mainstreaming adaptation. Primary survey of farmers revealed that the major impacts of climate change and variability perceived were change in the quantum, onset and distribution of rainfall, rise in minimum as well as maximum temperature levels, decline in crop yield and ground water depletion. The key socio-economic effects of climate change included farm unemployment, decline in farm income, rural migration and increased indebtedness among farmers. In order to cope with climate variability and change, farmers resorted to

different strategies such as use of crop varieties of suitable duration, water conservation techniques, crop insurance and participation in non-farm activities and employment guarantee schemes. Farmers' adaptation to changing climate is constrained by several technological, socio-economic and institutional barriers. These include limited knowledge on the costs-benefits of adaptation, lack of access to and knowledge of adaptation technologies, lack of financial resources and limited information on weather. Besides, lack of access to input markets, inadequate farm labour and limited farm size were the other constraints for adopting climate change adaptation strategies by the farmers.

For mainstreaming adaptation planning, the on-going development programmes were classified into six broad themes; *Productivity Enhancement and Production Augmentation, Rural Livelihood Security, Natural Resource Management, Risk Financing, Foodgrain Management and Research & Extension*. These broad groups accounted for a total budgetary allocation of Rs. 4,74,197 crore or about 24 per cent of the total budgetary outlay of the Government during the year 2016-17. Further, 161 development programmes under these broad themes were analysed in detail for exploring the possibilities of integrating climate change adaptation planning with them. The major ministries, wherein the climate adaptation strategies could be incorporated with the on-going development plans, were Ministry of Agriculture & Farmers' Welfare, Ministry of Environment, Forest and Climate Change, Ministry of Science and Technology, Ministry of Earth Sciences, Ministry of Water Resources, River Development & Ganga Rejuvenation, Ministry of Rural Development, Ministry of Panchayati Raj, Ministry of Skill Development and Entrepreneurship, Ministry of Consumer Affairs, Food and Public Distribution and the Ministry of Micro, Small & Medium Enterprises. Moreover, the promotion of the adaptation related activities are within the ambit of the following major agricultural centric on-going programmes; *Rashtriya Krishi Vikas Yojana, National Mission on Agricultural Extension and Technology, National Mission on Sustainable Agriculture (Paramparagat Krishi Vikas Yojana, Soil Health Card Scheme), Pradhan Mantri Krishi Sinchayee Yojana, Integrated Scheme on Agricultural Marketing, Mahatma Gandhi National Rural Employment Guarantee Scheme and Pradhan Mantri Fasal Bima Yojana*.

Further, on the basis of the grass-root elicitation and identification of relevant developmental programmes, a 'Need-Based Adaptation' planning incorporating farmers' perceptions on climate change impacts, constraints in the adoption of adaptation strategies and plausible adaptation options were linked with the most suitable on-going programmatic interventions of the Government.

The paper concludes that grass-root needs and constraints for various adaptation strategies and interventions should be an integral part of the program development and implementation. Moreover, rural developmental interventions are major drivers for enhancing the resilience of Indian agriculture and adaptive capacity of the vulnerable sections. However, further concerted efforts are needed to enhance awareness regarding these programmes amongst the various stakeholders. It is also important to ensure that the intended benefits of these schemes reach the targeted beneficiaries. There is also an urgent need to address the inefficiencies in the decentralized institutional mechanism and considerable time lag in adoption/implementation of the policy reforms by the state for creating conducive environment for diversification of rural income and managing village resources through community participation. Sensitizing the policy makers towards the program duplication and ensuring effective utilization of the available financial resources would bring prudence, effective targeting and outcome-oriented approach towards enhancing the resilience of Indian agriculture and vulnerable sections or regions.

1 Chapter

Introduction

1.1 Climate Change Adaptation in Agriculture

Climate change has emerged as one of the crucial issues of present era and exposure to climate-related risks has risen considerably. Scientific research has well established that global climate change has significant adverse impacts on many economic sectors, agriculture being the worst hit (Mendelsohn *et al.*, 2006; Nelson *et al.*, 2009). In the recent decades, changing temperature, precipitation pattern and recurrence of extreme weather events has further intensified the distress of the Indian agriculture system, which remains a mainstay for the rural folks. The effect of climate change on Indian agriculture is manifested through various ways; besides reducing crop productivity, it affects farm profitability, prices, supply and demand. Kumar and Parikh (2001) estimated that a 2°C increase in temperature and a 7 per cent increase in precipitation results in a loss of 8.4 per cent of total net-revenue for India. Hence, adaptation to climate variability and change in the system is imperative to sustain the productivity and profitability for the farmers in short to medium run (Singh *et al.*, 2015).

The process of adaptation intends to soften the climatic vulnerability and helps to reap the potential benefits through modification in the operations, practices and structures ranging from short term coping to long term, deeper transformations by the civil society, government and other stakeholders (IPCC, 2001; Tompkins and Adger, 2003). Adaptation interventions can be undertaken both at the farm level by an entity independently in response to the perceived and anticipated risks and at the top decision making level through conscious policy actions. Farming and rural communities adopt a range of strategies and practices owing to traditional/experiential knowledge evolved over the years in response to various risks. The strategies adopted at the farm level are driven by the potential climate impacts, agro-climatic and socio-economic factors, hence varies across regions. However, these autonomous strategies might be less effective in India, where 85% of the farming population consists of small and marginal farmers, with limited financial and technical capacity to withstand climatic shocks. Besides, the inequitable development pathway can lead to differential vulnerability and coping capacity among the

households, communities or regions as a whole (Dow & Kaspersen, 2006). Hence, the onus falls on the government to enhance resilience of Indian agriculture system, through deliberate and informed policy decisions.

1.2 Why Mainstreaming Adaptation into Development?

In the current national and international climate discourse, there is a rising emphasis on planned adaptation. It has been emphasized that adaptation planning must be developed and promoted within the broader economic developmental landscape, hence mainstreamed into the policy apparatus of the government. Mainstreaming adaptation has different meaning to different stakeholders depending on whether they hold a technology-based or development-based view of adaptation (Klein, 2008). In technology-based view, climate science projections and analysis are incorporated into the decision making process to develop climate resilient technologies, for example adoption of improved (drought/ pest tolerant) and short-duration crop varieties by the farmers over the possibility of declining rainfall. This approach mainly involves “climate proofing” of the existing development projects, which are more exposed to changing climate. However, this type of mainstreaming has been widely criticized for failing to fully address the non-climatic factors contributing to vulnerability and for not realizing the potential of development interventions to achieve climate resilience (Ayers *et al.*, 2014; Klein, 2008).

For a country like India, enhancing resilience of agricultural system is intricate, and requires a blend of interventions or approaches that addresses both climatic risks as well as structural/development deficits. Moreover, effective adaptation planning requires eliciting and understanding farmers’ perceptions and various coping mechanisms adopted (Jodha *et al.*, 2012; Ayanlade *et al.*, 2017). Designing or formulating programmes and policies for enhancing resilience to climate stress without considering the multitude of other factors that shape the vulnerability of different systems is of little worth (Lemos and Boyd, 2009). Thus, development-based view on adaptation which in addition to climate-proofing, aim at creating an enabling environment essential for successful adaptation is a more effective way of addressing climate induced vulnerability. The approach also addresses the various identified constraints (institutional, technological, socio-economic and infrastructural) to adaptation and strengthen the capacity of the locals and other stakeholders.

Mainstreaming climate change adaptation into agricultural development planning in India is still at an incipient stage. This may be due to lack of grass-root imperatives and empirical evidences, weak institutions, lack of capacity to understand the potential impacts of climate change at

micro-level, lack of comprehensive database and modeling framework, inadequate availability of actionable information, inappropriate funding and poor governance leading to implementation gaps. This requires paradigm shift among stakeholders/policy makers in analysing different actions related to climate change.

An attempt has been made in this paper, to elicit farmers' perceptions on climate change impacts, adaptation strategies followed in response to climatic risks, and the various barriers in their adoption. Further, the paper suggests 'Need-Based Adaptation' planning which integrates various farm level needs and constraints with existing programmatic interventions, thus depicting various entry points where climate adaptation planning can be mainstreamed with the Indian developmental agenda. This paper is an outcome of the study focusing on mainstreaming climate change adaptation policies in development planning, a part of the network project of Indian Council of Agricultural Research (ICAR) on National Innovations on Climate Resilient Agriculture (NICRA) that aims at evolving technologies and strategies for enhancing climate resilience in agriculture.

1.3 Data and Methodology

This work is based on both primary and secondary data. Micro-level perceptions of climate change and corresponding adaptation strategies followed were elicited at individual household level through primary survey and at community level using focus group discussions (FGDs). Two states, namely Telangana and Punjab, were selected for exploring micro-level adaptation status of farm households. Multi-stage sampling method was used for selecting the sample households. At the first stage, two districts Mahbubnagar from Telangana and Moga from Punjab were selected purposively from two different agro-climatic zones namely, Southern Plateau & Hill and Trans Gangetic Plain in order to capture diverse physiographic, climatic and other socio-economic aspects. At the second stage, two blocks were selected from each district and at third stage two villages were selected from each of the selected blocks. Finally, random sampling was used in selecting 20 farm households from each of the selected villages. Thus, a total of 160 respondents were selected for the study. The details of study villages and sample size are provided in the Table 1.

During field level elicitation, respondents were asked open-ended questions about the changes observed in the pattern of climate variables (rainfall and temperature), frequency of extreme weather events and the changes made in the crops and enterprises in response to perceived climatic changes. They were also asked to explicate the socio-economic impacts of

Table 1 : Study locale and sampling details

District	Block	Village	Sample Size	No. of participants in the FGDs
Mahbubnagar	Telkapalle	Zamistapur	20	40
		Pedduru	20	37
	Bomraspeta	Chowdarpalle	20	40
		Kothur	20	33
Moga	Bagha Purana	Sekha Kalan	20	41
		Gulab Singh Wala	20	36
	Moga	Daroli Bhai	20	34
		Kahan Singhwala	20	41
Total				
2 Districts	4 Blocks	8 Villages	160	302

climate variability, strategies/measures adopted at the farm level and the various constraints faced in coping with the changing climate.

Further, in order to develop a framework for mainstreaming adaptation planning into developmental landscape various existing programmes related to agriculture and rural development were classified into six broad thematic groups namely; *Rural Livelihood Security, Natural Resource Management, Productivity Enhancement and Production Augmentation, Risk Financing, Foodgrain Management and Research & Extension that are perceived to be the critical domains for enhancing the resilience of agriculture and rural communities to climate change.* A total of twenty-four ministries and 161 developmental programmes were identified during the year 2015-16 and 2016-17. Further, these broad thematic groups were segregated into 24 sub-groups and 52 categories. The Union Budgets of the Central Government and the Outcome Budgets of the selected ministries were compiled to quantify and assess the pattern of the budgetary expenditure over the broad thematic groups and sub-groups at three points of time 2010-11, 2015-16 and 2016-17.

Based on the field level observations an attempt was made to broadly categorize the opportunities for mainstreaming adaptation in the form of several options that can help to minimize or soften the climatic vulnerability of the farmers in the form of a 'Need-Based Adaptation' matrix. This approach integrates the various farm level impacts and constraints and the corresponding plausible options with the existing developmental programmes.

Chapter 2

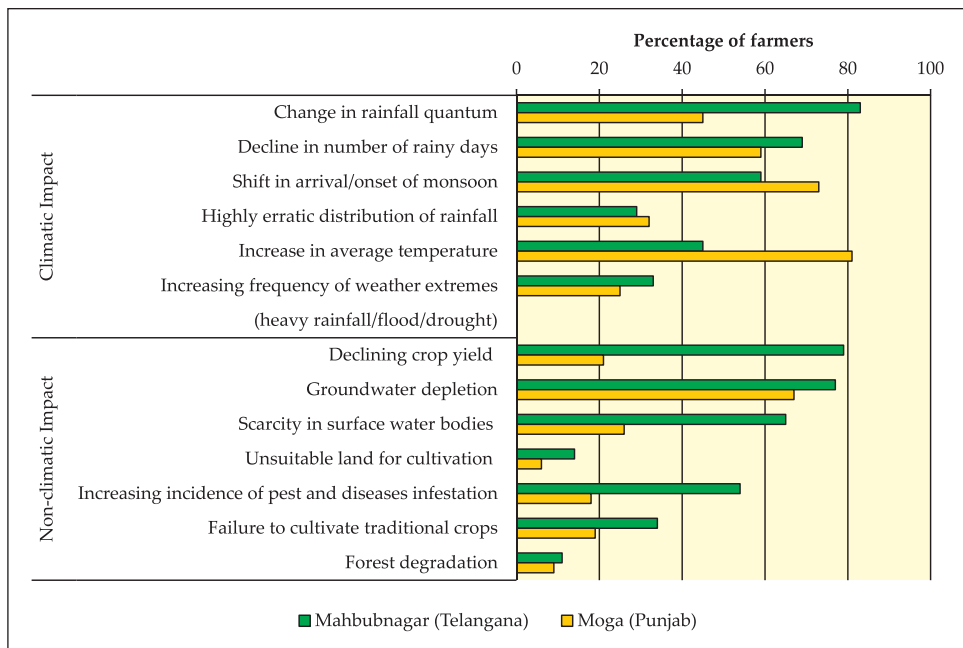
Micro-level Perceptions of Climate Change and Adaptation

The growing exposure to livelihood shocks from climate variability and change and limited resource base of the rural community to adapt has reinforced the need to mainstream climate adaptation planning into developmental landscape. However, a better understanding of micro-level perceptions is imperative for effective and informed planning at the macro-level.

2.1 Farmers' Perceptions on Climate Change Impacts

In order to have effective adaptation of farm centered strategies, farmers' knowledge about the climate change and its repercussions are pertinent for eliciting the grass-root imperatives. It was revealed that majority of the farmers perceived reduction in the number of rainy days over the years and continuous delay in the onset of monsoon (Figure1).

Figure 1 : Farmers' perceptions on climatic and non-climatic impacts

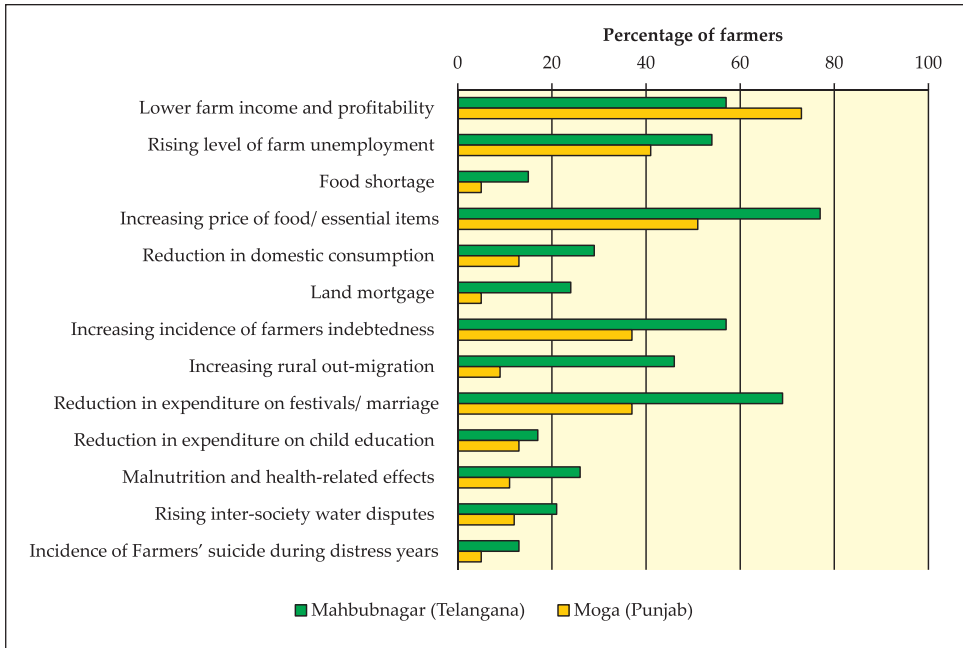


They also reported falling water tables on account of increased erraticism in rainfall. In addition, respondents from Mahbubnagar district expressed significant change in quantum of rainfall (83%) and increasing water scarcity in surface water bodies (65%) as the major impacts of climate change over the years. Further, varying temperature has encouraged pest and diseases proliferation (54%) in the region. Increasing atmospheric temperature adversely impact crop yield and induce water stress (Singh *et al.*, 2014). Similar situation seems to prevail in the Moga district of Punjab, where farmers perceived a notable change in the average temperature during summer and winter seasons (81%). This coupled with water intensive cropping pattern in the region, is further adding to the depletion of groundwater.

The farmers in both the selected districts unanimously agreed that unpredictable weather perils often jeopardize the village economy and are considered an important factor affecting livelihoods and socio-economic stability. Large number of respondents reported declining farm income and increasing indebtedness due to successive crop failures (Figure 2).

About 54% of respondents from Mahbubnagar opined high unemployment during the drought years, which compelled them to mortgage their productive assets to meet current needs. Farmers also reported a rise in considerations related to education of children,

Figure 2 : Farmers’ perceptions on socio-economic impacts of climate change



insufficient food for self-consumption and erosion of social/ community support system evident from growing water disputes in the society. Out-migration served as a temporary shelter especially during the drought period for the households in Mahbubnagar district. Moreover, 77% of the farmers in Mahbubnagar and 51% of the farmers in Moga stated that climatic variability has escalated the prices of necessary food items.

Marriage and festivals celebrations constitute an important part of household and village traditions. Rao (2001) reported that a typical rural household spends approximately seven times of its annual income on social events such a marriage; moreover, on an average 15% of its expenditure are spent on celebrating village festivals. The farmers expressed reduction in such expenditures. Incidence of farmers' suicide during the distress years was higher in Telangana. Various researchers have highlighted that drought along with inadequate government policies and societal issues might be the driving forces behind the spur in farmers' suicides (Shiva and Jalees, 2005).

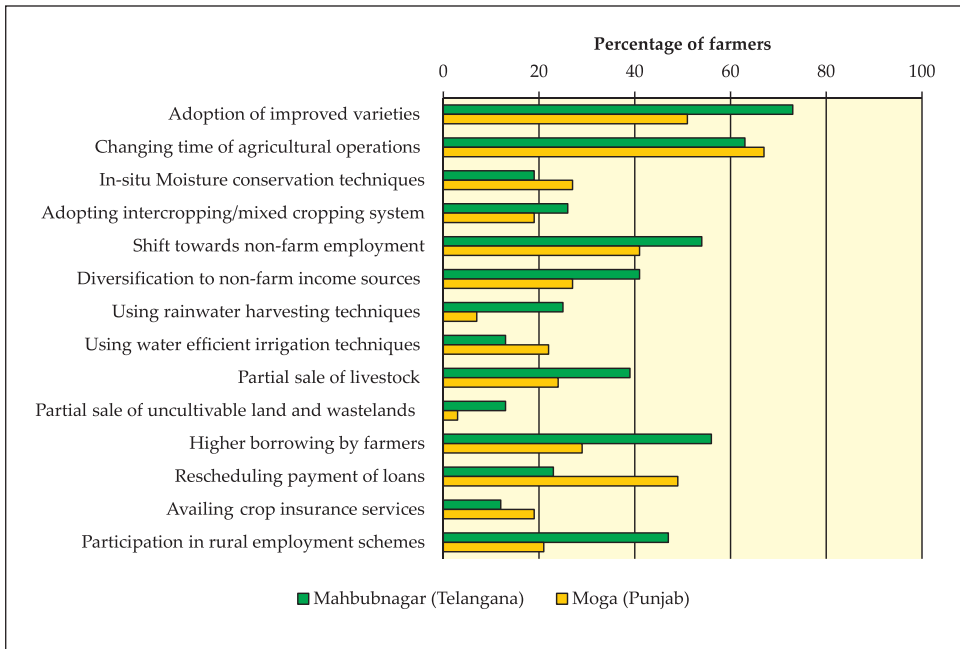
2.2 Farm and Household Level Adaptation Strategies

Farmers resort to different strategies to reduce vulnerability and losses due to climate variability and change. Several studies have been undertaken in developing countries to understand micro-level response strategies adopted to withstand weather adversities. Majority of the farm level adaptation strategies are based on agronomic practices, use of resource conservation technologies, water management and risk management measures. Similar findings have been reported by Sharma, 2013; Alauddin and Sarker, 2014; Dagar *et al.*, 2012; Sapkota, 2015; Pathak *et al.*, 2014; Tripathi and Mishra, 2017, and Tadesse *et al.*, 2015.

A large proportion of the farmers in the selected villages of both the districts were using drought/pest tolerant and short duration crop varieties as an adaptation measure (Figure 3). They were also making suitable changes in the cropping operations like changing planting dates, changing the amount of land grazed, etc. These practices were found to be relatively affordable and easier to implement. Farmers stated that they were adopting mixed cropping system as a way of minimizing risk of crop failure. A lesser proportion of the respondents in the study area reported on availing the crop insurance facilities.

For conserving water, farmers in the study districts were switching towards more economical and technologically efficient techniques like sprinklers and drip irrigation as an adaptation measure. However, their adoption remains low due to high initial cost of purchase, and complexity of the technology.

Figure 3 : Strategies adopted by farmers in response to climate changes



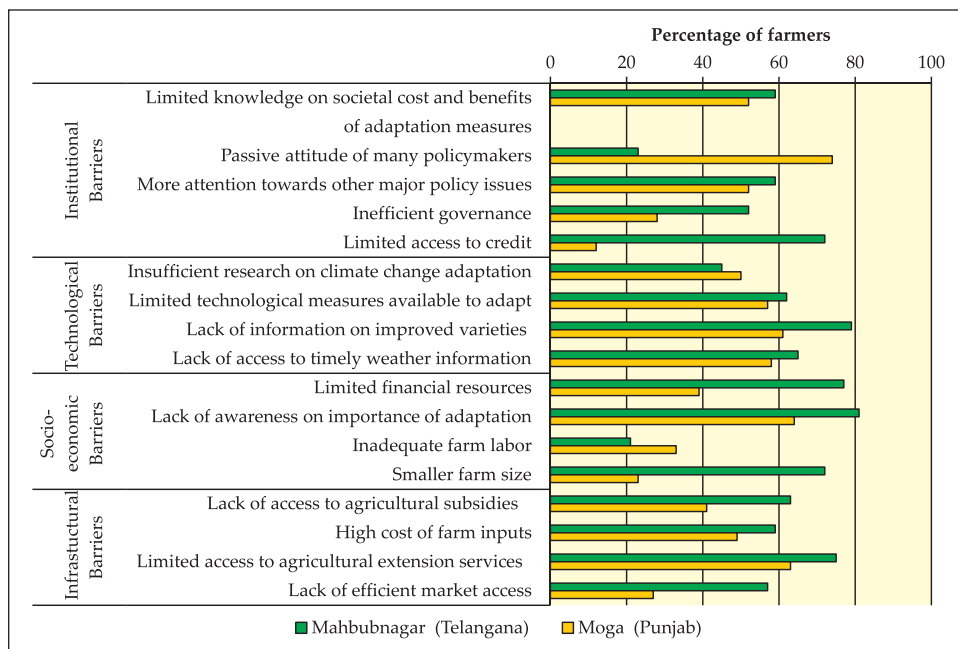
Moreover, many farmers in Moga mentioned rescheduling of loan payment (49%), whereas farmers in Mahbubnagar resorted to higher borrowing (56%) on account of yield loss and low profitability. Furthermore, to reduce exposure to livelihood shocks out-migration, diversification to non-agricultural enterprise and increasing participation in rural employment and social security programmes were observed as other adaptation strategies followed by the farmers.

2.3 Barriers to Climate Change Adaptation

There are a large number of institutional, technological, socio-economic and infrastructural barriers that limit the range of plausible climate adaptation options. Identifying these barriers to adaptation is crucial for finding possible opportunities to overcome them (Eisenack *et al.*, 2014). Farmers reported lack of information on water efficient crops (Mahbubnagar 79%; Moga 61%), limited access to agricultural extension service (Mahbubnagar 75%; Moga 63%) and delayed weather information (Mahbubnagar 65%; Moga 58%) as the major obstacles in adaptation (Figure 4). Other potential barriers as perceived by the farmers were limited knowledge on social costs and benefits of adaptation measures, high cost of farm inputs and limited access to agricultural markets.

Respondents from Mahbubnagar cited lack of access to formal credit as one of the major constraints to adaptation. Several studies have indicated

Figure 4 : Farmers’ response on potential barriers to climate change adaptation



that limited access to finance curtails the ability of the farmers to adopt better farm management practices to cope up with the climate induced distress (Berger and Troost, 2013). Further, lack of awareness on the need for adapting to the changing climate, uncertainty on the success of climate adaptation strategies/technologies, financial constraints for adopting the adaptation measures and limited farm size were the farm level socio-economic barriers especially in the case of Mahbubnagar district.

Thus, it can be construed that integration of these grass-root level perceptions on climate impacts, strategies followed to cope up with the climatic variability and the constraints faced in their adoption need to be addressed in order to effectively realize the dividends of various rural development programs. Moreover, this will also help macro-level decision making in better and pragmatic targeting of vulnerable and marginalized section amongst rural populace.

3 Chapter

Mainstreaming Climate Change Adaptation into Development Planning

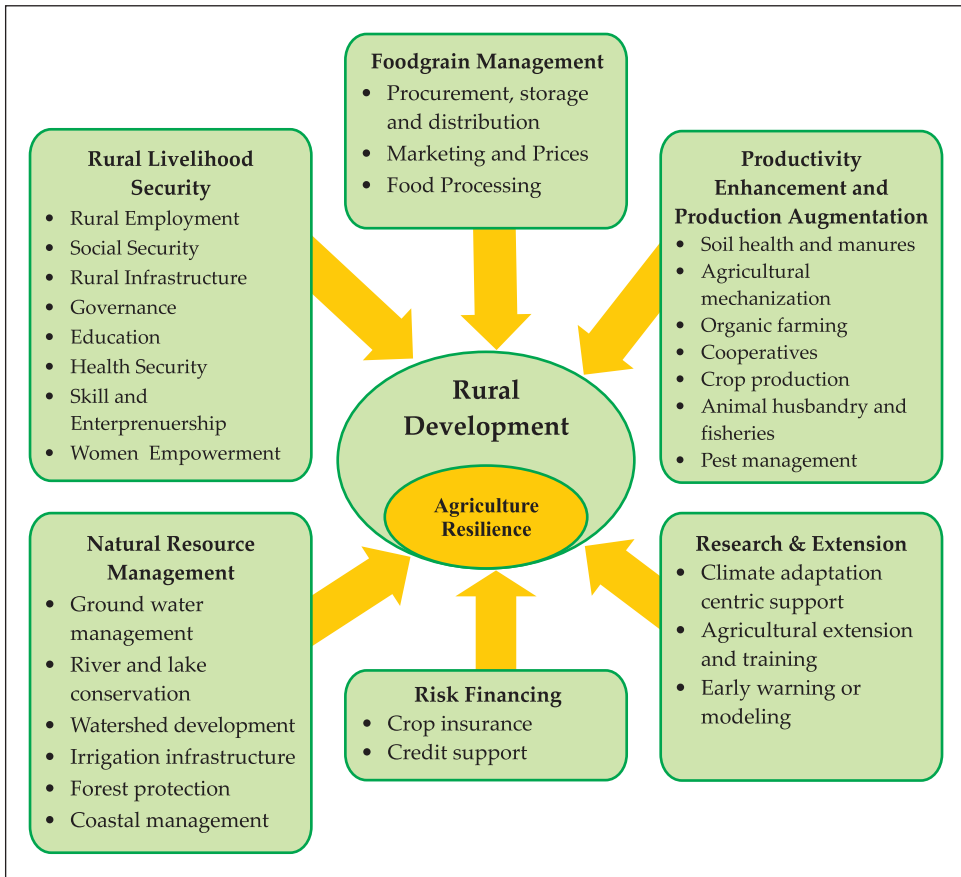
Among the various factors that create an enabling environment for farming community to adapt effectively, public policy plays a significant role. It has been emphasized that adaptation planning must be developed and promoted within the broader economic developmental landscape, hence mainstreamed into the policy apparatus of governments for its wide scale applicability. The magnitude of the need for adaptation in agricultural development has major implications for successful agricultural development planning to support food security and poverty reduction especially for the developing country like India. Mainstreaming in the context of climate change refers to the incorporation of climate change considerations into established or on-going development programs, policies or management strategies, in addition to implementing adaptation initiatives separately (UNDP-UNEP, 2011). The approach aims to create an enabling environment essential for successful adaptation by addressing both climatic and non-climatic factors.

3.1 Thematic Areas Identified for Mainstreaming Climate Change Adaptation Planning

In order to effectively mainstream climate change adaptation into development planning, it is essential to identify the programmatic interventions prevalent in the current developmental scheme of the government that explicitly or implicitly enhances the resilience of agriculture system to climate variability and change.

The study formulated *six* broad thematic groups namely; *Productivity Enhancement and Production Augmentation, Rural Livelihood Security, Natural Resource Management, Risk Financing, Foodgrain Management, and Research & Extension*, which are critical domains for integrating various dimensions of climate change (Figure 5). Against this, 24 ministries and 161 developmental programmes were selected during the year 2015-16 and 2016-17. Further, these broad thematic groups were segregated into different sub-groups and categories (Annexure-I). The rationale for the grouping and

Figure 5 : Critical domains and sub-groups of rural development for integrating climate adaptation planning



scheme selection is in synchronization with the broader effects of climate change on crop production and socio-economics of farm households identified from the field surveys as discussed in the earlier chapter.

- ❖ *Productivity Enhancement and Production Augmentation* possess wide range of interventions pertaining to nutrient management, genetic resource conservation, value chain management, integrated aquatic fish culture systems and conservation of riverine ecosystems that possess strong potential to develop and transform agriculture, livestock and fisheries sectors, making agricultural system more sustainable, profitable and climate resilient.
- ❖ *Risk Financing* includes schemes that aim at minimizing risk and uncertainty faced by the farmers in the event of adverse weather, natural calamities, pest and disease incidence, etc. Also, schemes ensuring easy and affordable access to credit have been included.

- ❖ *Foodgrain Management* domain consists of schemes that protect farmers against unexpected market price volatility, maintains buffer stock, strengthen and improve food processing capacity; also aims at establishment and modernization of cold storage facilities, warehouses, etc.
- ❖ *Rural Livelihood Security* contains programmes that primarily aim at sustaining and diversifying livelihoods. Broadly, the group focuses on:
 - Building human capabilities through promotion of skill and entrepreneurship, education entitlement, health security, infrastructure development.
 - Provision of safety net through unconditional cash and kind transfers, wage employment opportunities, efficient and effective grass-root institutions.
- ❖ *Natural Resource Management* encompasses programmatic interventions that have multidimensional implications in improving climate resilience of agro-ecosystems. Activities under this domain promote water and soil conservation, afforestation, biodiversity conservation, development of irrigation facilities, coastal management, etc.
- ❖ *Research & Extension* lays emphasis on strategic research, technology demonstrations, efficient early warning system and capacity building activities in the field of climate change adaptation and mitigation.

3.2 Budgetary Allocations for Programmes under Identified Thematic Areas

Premised on the identification and segregation of programmes/schemes, budgetary allocations on the various thematic areas and sub-groups have been discussed in this section. These thematic groups and sub-groups are perceived as critical areas for fostering adaptive capacity and reducing vulnerability of agriculture sector to climate change. The Union Budgets of the Central Government and the Outcome Budgets of the selected ministries were compiled to quantify and assess the pattern of the budgetary expenditure over these groups at three points of time 2010-11, 2015-16 and 2016-17.

The proportion of the total budgetary outlay on rural livelihood security, natural resource management and production augmentation, which constitutes the critical foundation of rural development showed a decline over the three-year period. Further, it seems that risk financing is

getting additional attention, in the last few years, which is evident from the marked increase in its allocation (Table 2). In case of foodgrain management, the expenditure increased during the year 2015-16, however, showed a decline in 2016-17. Moreover, it was observed that the total percentage allocation on all the critical domains has fallen from 26.4 in the year 2010-11 to 25.6 in 2015-16 and 24.0 in 2016-17. Of this total expenditure on critical domains, rural livelihood security continues to dominate, whereas expenditure on research & extension and risk financing forms only a small proportion for all the three years.

Table 2 : Comparative budgetary allocation across the identified critical domains

Broad thematic group	2010-11		2015-16		2016-17	
	R.E. (in Rs. crores)	% of Total Outlay	R.E. (in Rs. crores)	% of Total Outlay	B.E. (in Rs. crores)	% of Total Outlay
I. Rural Livelihood Security	177280.6	14.1	197068.2	11.1	215888.8	10.9
II. Natural Resource Management	14318.8	1.1	9918.1	0.6	9100.1	0.5
III. Productivity Enhancement and Production Augmentation	67362.8 (12386.1)*	5.4 (1.0)*	81579.8 (9142.2)*	4.6 (0.5)*	82039.4 (12039.4)*	4.2 (0.6)*
IV. Risk Financing	7193.0	0.6	15967.0	0.9	20501.2	1.0
V. Foodgrain Management	64357.6	5.1	147686.9	8.3	144630.7	7.3
VI. Research & Extension	1346.3	0.1	1970.0	0.1	2036.6	0.1
Total (I+II+III+IV+V+VI)	331859.2	26.4 (22.0)*	454189.9	25.6 (21.5)*	474196.8	24.0 (20.4)*
Total Budgetary Outlay	1257728.8		1777477.0		1978060.5	

Note: (*) Figures after exclusion of Fertilizer Subsidy; R.E.: Revised Estimates; B.E.: Budget Estimates.
Source: Authors compilation from Union Budgets, Government of India and Outcome Budgets of ministries, various years.

The relative importance attached to the various sub-groups under the identified thematic domains is elaborated in Table 3. In case of rural livelihood security, major proportion of the overall allocation is towards rural employment, infrastructure, health and education. Rural employment encompassing the flagship programmes (MGNREGS, National Rural Livelihood Mission) of the government responsible for providing livelihood security showed an increase in its allocation from 2010-11 to 2015-16. Further, there was a rise in budgetary expenditure in the case of health security, social security and skill & entrepreneurship development in 2016-17. Such an increase in allocation for these domains was largely driven by the launch of various new ventures by the government for promoting entrepreneurship and upgrading skills of the rural youth and providing succour through pensions and insurance. Following the discontinuation of Backward Region Grant Fund, budgetary allocation on rural governance plummeted from 4 per cent in 2010-11 to 0.10 per cent in 2015-16.

Table 3 : Budgetary allocations on different sub-groups under the critical domains

Sub-Group	2010-11		2015-16		2016-17	
	R.E. (in Rs. crores)	% in Total	R.E. (in Rs. crores)	% in Total	B.E. (in Rs. crores)	% in Total
I. Rural Livelihood Security						
<i>i. Rural Employment</i>	44107.1	24.9	40947.7	20.8	42639.0	19.8
<i>ii. Social Security & Welfare</i>	5595.9	3.2	10464.3	5.3	11800.0	5.5
<i>iii. Rural Infrastructure Development</i>	39038.5	22.0	36831.0	18.7	41280.0	19.1
<i>iv. Rural Governance</i>	7268.3	4.1	191.0	0.1	725.0	0.3
<i>v. Skill & Entrepreneurship Development</i>	835.3	0.5	2307.8	1.2	5410.5	2.5
<i>vi. Health Security</i>	34267.7	19.3	43906.1	22.3	50265.7	23.3
<i>vii. Education</i>	34342.6	19.4	43713.6	22.2	45407.2	21.0
<i>viii. Women Empowerment and Child Development</i>	10169.9	5.7	16966.7	8.6	16690.6	7.7
<i>ix. Holistic Development</i>	1655.4	0.9	1740.0	0.9	1671.0	0.8
Sub-total	177280.6	100.0	197068.2	100.0	215888.8	100.0
II. Natural Resource Management						
<i>i. Water Management and Soil Conservation</i>	13758.4	96.1	9517.9	96.0	8570.4	94.2
<i>ii. Forest and Biodiversity Conservation</i>	350.7	2.5	241.7	2.4	255.0	2.8
<i>iii. Coastal Management</i>	209.7	1.5	158.5	1.6	274.7	3.0
Sub-total	14318.8	100.0	9918.1	100.0	9100.1	100.0
III. Productivity Enhancement and Production Augmentation						
<i>i. Integrated Nutrient Management</i>	41.9	0.1	516.4	0.6	855.1	1.0
<i>ii. Improving Input Supply and Service delivery System</i>	55397.4	82.2	72712.3	89.1	70394.7	85.8
<i>iii. Plant Protection</i>	60.2	0.1	81.2	0.1	154.1	0.2
<i>iv. Animal Husbandry and Fisheries</i>	348.5	0.5	859.5	1.1	1042.8	1.3
<i>v. Cooperatives</i>	86.2	0.1	112.9	0.1	130.0	0.2
<i>vi. Integrated Development</i>	11428.7	17.0	7297.5	9.0	9462.8	11.5
Sub-total	67362.8	100.0	81579.8	100.0	82039.4	100.0
IV. Risk Financing						
<i>Insurance and Credit Support</i>	7193.0	100.0	15967.0	100.0	20501.2	100.0
Sub-total	7193.0	100.0	15967.0	100.0	20501.2	100.0
V. Foodgrain Management						
<i>i. Procurement, Storage and Distribution</i>	63650.9	98.9	145728.6	98.7	141989.1	98.2
<i>ii. Marketing and Prices</i>	513.4	0.8	1527.3	1.0	2021.9	1.4
<i>iii. Food Processing</i>	193.3	0.3	431.0	0.3	619.7	0.4
Sub-total	64357.6	100.0	147686.9	100.0	144630.7	100.0
VI. Research & Extension						
<i>i. Climate Adaptation Centric Support</i>	180.0	13.4	341.8	17.4	240.0	11.8
<i>ii. Information Dissemination</i>	1166.3	86.6	1628.2	82.7	1796.6	88.2
Sub-total	1346.3	100.0	1970.0	100.0	2036.6	100.0

Note: B.E.- Budget Estimates; R.E.- Revised Estimates.

Source: Authors compilation from Union Budgets, Government of India and Outcome Budgets of ministries, various years.

Natural resource management constitutes the most significant aspect of adaptation to climate change. Under this, water and soil conservation group, encompassing programmes pertaining to ground water, irrigation,

watershed, river and lake conservation, bagged the highest percentage of the expenditure in 2010-11. However, there was a slight decline in the allocation to this domain over the years. Besides, other two sub-groups targeting forest, biodiversity conservation and coastal management showed an increase in proportion of total budgetary allocation. Under the Productivity Enhancement and Production Augmentation group, input supply and integrated development are the two sub-groups that account for the largest proportion of the overall allocation. It is to be noted that, such a large proportion of expenditure in the case of input supply, was due to inclusion of fertilizer subsidy. Further, an increase in expenditure over the years was found in all other sub-groups. In the last few years, the role of credit and crop insurance programmes has relatively increased given the increasing threat to the agrarian livelihood, which is well resonated by a marked increase in its overall allocation. Proportion of budgetary outlays on sub-groups under the foodgrain management followed a steady pattern, with a major focus on procurement, storage and distribution. In case of research and extension, information dissemination, agricultural extension, biotechnology, forecasting, early warning system related schemes accounted for a larger proportion of overall allocation, whereas adaptation centric initiatives witnessed a dip in its allocation in the current year preceding a rise.

3.3 Need-Based Adaptation Planning: Aligning Micro-level Issues and Macro-level Interventions

Indian rural and agricultural development policy, though documents the likely consequences of climate change, it often lacks a plan of adaptation actions. Most of these policies are blanket or highly aggregative in nature and thus fails to address and understand the various micro-level suffering and constraints. Macro-level projections and analysis often does not offer inspiring and sufficient lead lines due to information gaps and large scale uncertainties (Singh *et al.*, 2015). Thus, understanding micro-level realities and incorporating them with the macro-level decision making is an effective approach for designing appropriate strategy for successfully enhancing resilience of agriculture system to climate variability and change.

Based on the field level observations we attempted to broadly categorize the opportunities for mainstreaming adaptation in the form of several options that can help to minimize or soften the climatic vulnerability of the farmers, thus ensuring livelihood security. The following 'Need-Based Adaptation' matrix (Table 4) integrates the various farm level impacts and constraints and the corresponding plausible options with the existing developmental programmes. This approach represents various

entry points where climate adaptation planning can be incorporated. Further, it also unravels the programmatic interventions that not only achieve conventional macroeconomic objectives but can hasten the process of developing resilience to climatic variability in rural landscape.

Making farmers aware about the changes in the climate parameters and the importance of adaptation to these changes is prerequisite for minimizing the risks and securing their livelihoods.

Table 4 : Issues and plausible options for mainstreaming climate change adaptation planning with existing development programmes

(a) Grass-root constraints and options for potential adaptation strategies

Issues	Plausible options	On-going development programmes for mainstreaming adaptation strategies
Lack of information/ awareness on adaptation technologies and limited agricultural extension services	<ul style="list-style-type: none"> • Strengthening dissemination of climate change adaptation technologies and building extension infrastructure 	<ul style="list-style-type: none"> ✓ National Mission on Agricultural Extension & Technology: Sub Mission on Agriculture Extension ✓ <i>Rashtriya Krishi Vikas Yojana</i> ✓ National Mission on Oilseeds and Oil Palm ✓ National Food Security Mission
Limited technologies for climate change adaptation	<ul style="list-style-type: none"> • Promoting R&D activities for developing improved technologies such as less water consuming, early maturing, high yielding for climate resilience in agriculture 	<ul style="list-style-type: none"> ✓ National Mission on Sustainable Agriculture ✓ National Innovations on Climate Resilient Agriculture
Limited knowledge on adaptation costs and benefits	<ul style="list-style-type: none"> • Promoting research on climate change adaptation costs and benefits • Building capacity and awareness among various stakeholders on impacts and adaptation options • Encouraging the role of NGOs for enhancing adaptation preparedness 	<ul style="list-style-type: none"> ✓ National Mission on Sustainable Agriculture ✓ National Innovations on Climate Resilient Agriculture
High cost of farm inputs	<ul style="list-style-type: none"> • Improved access to subsidised seeds (stress tolerant varieties), planting material, machinery (conservation agriculture), plant protection chemicals etc. 	<ul style="list-style-type: none"> ✓ National Mission on Agricultural Extension & Technology: <ul style="list-style-type: none"> • Sub Mission on Seed and Planting Material • Sub Mission on Agricultural Mechanization • Sub Mission on Plant Protection and Plant Quarantine ✓ <i>Rashtriya Krishi Vikas Yojana</i> ✓ National Mission on Oilseeds and Oil Palm ✓ National Food Security Mission

In line with the commitments to the global negotiations, since 2008 India has initiated various climate centric interventions like National Action Plan on Climate Change, National Adaptation Fund, and National Innovations on Climate Resilient Agriculture.

Table 4 (b) : Climate change impacts perceived by the farmers

Issues	Plausible options	On-going development programmes for mainstreaming adaptation strategies
<i>Direct impact of climate change as perceived by the farmers</i>		
Change in quantum of rainfall/rainy days/alterd onset of monsoon as well as variations in temperature	<ul style="list-style-type: none"> Improving irrigation and drainage infrastructure Promotion of micro-irrigation methods (drip and sprinklers) Ground water recharge, aquifer mapping 	<ul style="list-style-type: none"> ✓ Pradhan Mantri Krishi Sinchayee Yojana: <ul style="list-style-type: none"> Accelerated Irrigation & Flood Management Programme Integrated Watershed Management Programme
Ground water depletion	<ul style="list-style-type: none"> Water harvesting infrastructure at farm level and community level Use of short duration varieties/ stress tolerant varieties 	<ul style="list-style-type: none"> • On Farm Management ✓ National Water Mission ✓ National Mission on Sustainable Agriculture ✓ National Innovations on Climate Resilient Agriculture ✓ Groundwater Management and Regulation Scheme ✓ National River Conservation Plan
Extreme weather events	<ul style="list-style-type: none"> Accurate weather forecasts and early warning system Disaster relief mechanisms and funding Active weather based agro-advisories at the farm level 	<ul style="list-style-type: none"> ✓ Flood Forecasting ✓ Numerical Modelling of Weather & Climate ✓ Agro-Meteorological Services Programme
Increased pest and disease incidence	<ul style="list-style-type: none"> Integrated pest and disease management 	<ul style="list-style-type: none"> ✓ Mission on Plant Protection and Plant Quarantine ✓ Rashtriya Krishi Vikas Yojana ✓ National Mission on Oilseeds and Oil Palm ✓ National Food Security Mission
Land degradation	<ul style="list-style-type: none"> Land management Nutrient management 	<ul style="list-style-type: none"> ✓ National Project on Management of Soil Health and Fertility ✓ Soil Health Card Scheme
Forest degradation	<ul style="list-style-type: none"> Afforestation and regeneration of degraded forest Strengthening of infrastructure for forest protection Sustainable and equitable distribution of forest products Encouraging local participation in decision making 	<ul style="list-style-type: none"> ✓ National Afforestation Programme ✓ Intensification of Forest Management Scheme ✓ Green India Mission ✓ Van Bandhu Kalyan Yojana

Indirect impact of climate change as perceived by the farmers

Crop failure	<ul style="list-style-type: none"> • Risk management through crop insurance with universal coverage. • Improved access to credit to cover weather extremes • Addressing middle and last mile challenges 	<ul style="list-style-type: none"> ✓ Pradhan Mantri Fasal Bima Yojana ✓ Weather Based Crop Insurance Scheme ✓ Interest Subvention Scheme for Short Term Crop Loans ✓ Kisan Credit Card Scheme ✓ Pradhan Mantri Jan Dhan Yojana
Decline in farm income	<ul style="list-style-type: none"> • Integrated farming/enterprise diversification • Diversification to high value crop (HYCs) • Improvement in food processing capacity and value addition • Improved market access and building rural infrastructure 	<ul style="list-style-type: none"> ✓ Integrated Scheme for Agricultural Marketing ✓ e-National Agriculture Market Scheme ✓ Price Stabilization Scheme ✓ Agri-Tech Infrastructure Fund ✓ Paramparagat Krishi Vikas Yojana ✓ National Project on Promotion of Organic Farming ✓ Mission for Integrated Development of Horticulture ✓ Mega Food Parks ✓ Cold Chain Value Addition and Preservation Infrastructure ✓ Pradhan Mantri Gram Sadak Yojana ✓ Deen Dayal Upadhyaya Gram Jyoti Yojana
Rising farm unemployment and rural migration	<ul style="list-style-type: none"> • Creation of off-farm and non-farm employment vista for diversifying income 	<ul style="list-style-type: none"> ✓ Mahatma Gandhi National Rural Employment Guarantee Scheme ✓ National Rural Livelihood Mission: Ajeevika ✓ Pradhan Mantri Kaushal Vikas Yojana ✓ Prime Minister's Employment Generation Programme ✓ Dairy Entrepreneurship Development Scheme ✓ National Dairy Plan ✓ Development of Inland Fisheries & Aquaculture
Food shortage and Malnutrition	<ul style="list-style-type: none"> • Astute management of food supply 	<ul style="list-style-type: none"> ✓ Buffer Stock Policy ✓ Targeted Public Distribution System

NICRA is an initiative by the ICAR, launched in the year 2011, is playing a significant role in fostering the process of climate adaptation through strategic research and technology demonstrations in the area of

crops, livestock, fisheries and natural resource management. Development and dissemination of climate smart technologies will greatly help in improving agriculture productivity and production, whilst ensuring management of natural resources in the country.

Further, the National Mission for Sustainable Agriculture is one of the eight missions under the NAPCC, aims at promoting sustainable agriculture through a series of adaptation measures focusing on ten key dimensions encompassing Indian agriculture namely; improved crop seeds, livestock and fish cultures, water use efficiency, pest management, improved farm practices, nutrient management, agricultural insurance, credit support, markets, access to information and livelihood diversification.

Agriculture research system has generated a large number of technologies, however their adoption at farmers' level remains at a very low level especially in marginal environments and disadvantaged regions. Building an active extension system with establishment of technology management agencies at district level, capacity building, and knowledge delivery via ICT/Mass Media through National Mission on Agricultural Extension & Technology, *Rashtriya Krishi Vikas Yojana*, and National Food Security Mission will encourage farmers in adapting to climate variability.

Improved access to subsidized seeds (stress tolerant varieties), planting material, machinery (conservation agriculture), plant protection chemicals, etc. will further help them in exercising adaptation strategies.

Higher risk of crop failure owing to erratic distribution of rainfall discourages investment in agriculture production and productivity. Insurance against climate induced crop failure through *Pradhan Mantri Fasal Bima Yojana* and Weather Based Crop Insurance Scheme will ensure continued investment in crop production. Further, easy access to credit to cover weather based adversities on subsidized interest rates through Interest Subvention and Kisan Credit Card scheme can reduce indebtedness and enable them to buy modern inputs.

Promotion of location specific water conservation and management technologies and strengthening infrastructure, via *Pradhan Mantri Krishi Sinchayee Yojana*, Groundwater Management and Regulation Scheme and National Water Mission can help in stabilizing farmers' income. Reliable early warning system of environmental changes coupled with policies to support the diffusion of this information can also help farmers, agriculture-dependent industries and policymakers in informed decision making. (Jat *et al.*, 2016). Interventions like flood forecasting, agro-meteorological services are of great support in this context.

Integrated Scheme for Agricultural Marketing, e-National Agriculture Market and Mission for Integrated Development of Horticulture through

improved market access and post-harvest management will encourage farmers to diversify towards high value products. Also development of food processing sector through ventures like Mega Food Parks programme is crucial for value addition to agricultural produce and improving farmers' income.

Further, creation of adequate off-farm and non-farm employment opportunities will greatly help farmers in diversifying their income leading to lesser out migrations. Employment diversification however, requires minimum level of education and skills which can be addressed through schemes like *Pradhan Mantri Kaushal Vikas Yojana* and other skill and education enhancement interventions of the government. Also, continuous supply of electricity (via, *Deen Dayal Upadhyaya Gram Jyoti Yojana*) and road connectivity (via, *Pradhan Mantri Gram Sadak Yojana*) is crucial for accelerating growth and development of agriculture sectors.

All the above programmes operationalized by the Government of India, possess great potential in addressing the vulnerability of the farmers and rural households to climate change and variability but for the want of adaptation focus and lack of convergence in programme implementation, the desired outcomes are far from reality. Thus, there is a dire need of coherence in climate adaptation planning.

4 Chapter

Conclusions and Policy Implications

Climate change induced increased variability in temperature and rainfall and intensity of extreme weather events like drought and flood create disturbance to agro-ecosystems ultimately leading to yield and income loss to farmers. Though the farmers are not aware about the climate change as a long term phenomenon, they often understand the changes in rainfall events and temperature and resort to farm level or household level coping mechanisms or adaptive strategies. These autonomous strategies/mechanisms can help in finding short term and immediate solution for weather induced stress in agriculture, however designing and formulating sustainable adaptation strategies are essential for achieving climate resilience in agriculture.

Micro-level survey showed that change in crop management (use of crop varieties of suitable duration or tolerance to climate stress) or changes in land use management are the most widely used adaptation strategies at farm level. Livelihood diversification of the households by engaging in non-farm activities and employment guarantee schemes were also found to be prominent adaptation strategies of agricultural households to climate change. Various factors such as endowment of human capital, physical and financial capital often influence the adaptation decision of these households.

Farmers follow voluntary adaptation strategies based on perceived climate impacts which might be less effective in dealing with the climate induced vulnerability. Thus, it is very important to facilitate informed decision making among farmers on sustainable adaptation strategies in a location specific manner. To satisfy location specific needs of climate resilience agricultural technologies and practices, continued R & D efforts are also needed.

Mainstreaming climate change considerations in development planning can help in enhancing adaptation and achieving climate resilience in agriculture. The major climate centric interventions by the Government of India like, NAPCC, National Adaptation Fund, and ICAR-NICRA are important platforms for promoting adaptation at the farm level.

Moreover, the promotion of the adaptation related activities could be done with the following major on-going programmes; *Rashtriya Krishi Vikas Yojana*, National Mission on Agricultural Extension and Technology, National Mission on Sustainable Agriculture (*Paramparagat Krishi Vikas Yojana*, Soil Health Card Scheme), *Pradhan Mantri Krishi Sinchayee Yojana*, Integrated Scheme on Agricultural Marketing, Mahatma Gandhi National Rural Employment Guarantee Scheme and *Pradhan Mantri Fasal Bima Yojana*.

Budgetary expenditure indicated that the share of rural livelihood security, natural resource management and production augmentation which constitutes the critical foundation of rural development reduced whereas in case of risk financing a significant increase in financial allocation was observed. In case of foodgrain management surge that was seen, dipped in the year 2016-17. Moreover, in terms of total adaptation expenditure, rural livelihood security continue to dominate, whereas expenditure on research & extension and risk financing forms only a small proportion of the total outlay.

In a nutshell, it is construed that grass-root needs and constraints for various adaptation strategies and interventions should be an integral part of the program development, implementation and evaluation in the entire developmental paradigm. The policy makers must be sensitized towards the program duplication issue and in ensuring effective utilization of the available financial resources thereby bringing prudence and effective targeting. Moreover, rural developmental interventions are the major drivers in enhancing the adaptive capacity of the vulnerable sections and thereby contributing significantly to make Indian agriculture more resilient. Concerted efforts are needed to enhance awareness at the grass-root level regarding the programmes and efforts made to ensure that intended benefits of these schemes must reach the targeted beneficiaries for enhancing the resilience of Indian agriculture.

References

- Alauddin, M. and Sarker, M.A.R. (2014). *Climate change and farm-level adaptation decisions and strategies in drought-prone and groundwater-depleted areas of Bangladesh: An empirical investigation*. *Ecological Economics*, **106**:204-213.
- Ayanlade, A., Radeny, M. and Morton, J.F. (2017). *Comparing smallholder farmers perception of climate change with meteorological data: A case study from south-western Nigeria*. *Weather and Climate Extremes*, **15**:24-33.
- Ayers, J.M., Huq, S., Faisal, A.M. and Hussain, S.T. (2014). *Mainstreaming climate change adaptation into development: a case study of Bangladesh*. *Wiley Interdisciplinary Reviews: Climate Change*, **5**(1): 37-51.
- Berger, T. and Troost, C. (2014). *Agent-based modelling of climate adaptation and mitigation options in agriculture*. *Journal of Agricultural Economics*, **65**(2):323-348.
- Dagar, J.C., Singh, A.K., Singh, R. and Arunachalam, A.A. (2012). *Climate change vis-à-vis Indian agriculture*. *Annals of Agricultural Research*, **33**(4): 189-203.
- Dow, K.R. and Kasperson (2006). *Exploring the social justice implications of adaptation and vulnerability*. In: *Fairness in Adaptation to Climatic Change*, Eds: N. Adger, J. Paavola, S.Huq and M. J. Mace. Cambridge, MA, MIT Press, 79-96.
- Eisenack, K., Moser, S.C., Hoffmann, E., Klein, R.J., Oberlack, C., Pechan, A., Rotter, M. and Termeer, C.J. (2014). *Explaining and overcoming barriers to climate change adaptation*. *Nature Climate Change*, **4**(10):867-872.
- Government of India. (various years). *Expenditure Budgets (Volume 1 & Volume 2) of Union Budget Documents*, Ministry of Finance, New Delhi.
- IPCC (2001). *Climate Change 2001: Impacts, adaptation and vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Eds: J.J. McCarthy, O.F. Canziani, N.A. Leary, D.J. Dokken and K.S. White. Cambridge, UK and New York, USA, Cambridge University Press, 981-996.

- Jat, M.L., Dagar, J.C., Sapkota, T.B., Singh, Y., Govaerts, B., Ridaura, S.L., Saharawat, Y.S., Sharma, R.K., Tatarwal, J.P., Jat, R.K., Hobbs, H. and Stirling, C. (2016). *Climate change and agriculture: Adaptation strategies and mitigation opportunities for food security in South Asia and Latin America*. In: *Advances in Agronomy*, Eds: Donald L. Sparks, Academic Press, 127-235.
- Jodha, N.S., Singh, N.P. and Bantilan, M.C.S. (2012). *Enhancing farmers' adaptation to climate change in arid and semi-arid agriculture of India: Evidences from indigenous practices: Developing international public goods from development-oriented Projects*. Working Paper Series No. 32. ICRISAT, Patancheru, AP, India.
- Klein, R.J.T. (2008). *Mainstreaming climate adaptation into development policies and programmes: A European perspective*. In: *European Parliament, Eds: Financing Climate Change Policies in Developing Countries*. Brussels: European Parliament, 38–50.
- Kumar, K.K. and Parikh, J. (2001). *Indian agriculture and climate sensitivity*. *Global Environmental Change*, **11**(2):147-154.
- Lemos, M.C. and Boyd, E. (2009). *The politics of adaptation across scales: The implications of additionally to policy choices and development*. In: *The politics of climate change: A survey*, Eds: M. T., Boycoff. Taylor & Francis: London, UK, 2010; ISBN 978-0-415-61356-9.
- Mendelsohn, R., Dinar, A. and Williams, L. (2006). *The distributional impact of climate change on rich and poor countries*. *Environment and Development Economics*, **11**(2):159-178.
- Nelson, G.C., Rosegrant, M.W., Koo, J., Robertson, R., Sulser, T., Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka, M., Magalhaes, M., Valmonte-Santos, R., Ewing, M. and Lee, D. (2009). *Climate change impact on agriculture and cost of adaptation*. Food Policy Report, International Food Policy Research Institute, Washington DC.
- Pathak, H., Pramanik, P., Khanna, M. and Kumar, A. (2014). *Climate change and water availability in Indian agriculture: impacts and adaptation*. *Indian Journal of Agricultural Sciences*, **84**: 671-679.
- Rao, V. (2001). *Poverty and public celebrations in rural India*. *The Annals of the American Academy of Political and Social Science*, **573**(1):85-104.
- Sapkota, T.B., Jat, M.L., Aryal, J.P., Jat, R. K. and Khatri-Chhetri, A. (2015). *Climate change adaptation, greenhouse gas mitigation and economic profitability of conservation agriculture: Some examples from cereal systems of Indo-Gangetic Plains*. *Journal of Integrative Agriculture*, **14**(8):1524-1533.

- Sharma, B.R. (2013). *Impact of climate change on water resources and potential adaptations for Indian agriculture*. *Annals of Agricultural Research*, **34**(1):1-14
- Shiva, V. and Kunwar, J. (2005). *Farmers suicides in India*. Research Foundation for Science, Technology and Ecology, New Delhi, India.
- Singh, N.P., Bantilan, C. and Byjesh, K. (2014). *Vulnerability and policy relevance to drought in the semi-arid tropics of Asia—A retrospective analysis*. *Weather and Climate Extremes*, **3**:54-61.
- Singh, N.P., Bantilan, C., Byjesh, K., Nedumaran, S., Rao, V.U.M., Venkateswarulu, B., Niranjana, F., Jayatilaka, W., Deb, U.K., Ha, P.Q. and Suddhiyam, P. (2015). *Moving along adaptation pathways toward grass-root resilience: A synthesis*. In: *Climate Change Challenges and Adaptations at Farm-level: Case Studies from Asia and Africa*, Eds: N. P. Singh, C. Bantilan, K. Byjesh, and S. Nedumaran. CABI Private Limited, 197-211.
- Singh, N.P., Byjesh, K. and Bantilan, C. (2015). *Climate change vulnerability and adaptation strategies with a rural-farm level perspective: A retrospection*. In: *Climate Change Challenges and Adaptations at Farm-level: Case Studies from Asia and Africa*, Eds: N. P. Singh, C. Bantilan, K. Byjesh, and S. Nedumaran. CABI Private Limited, 1-10.
- Tadesse, M.A., Shiferaw, B.A. and Erenstein, O. (2015). *Weather index insurance for managing drought risk in smallholder agriculture: Lessons and policy implications for Sub-Saharan Africa*. *Agricultural and Food Economics*, **3**(1):26.
- Tompkins, E. L. and Adger, W.N. (2003). *Building resilience to climate change through adaptive management of natural resources*. Tyndall Working Paper 27. Tyndall Centre for Climate Change Research, University of East Anglia, Norwich, UK.
- Tripathi, A. and Mishra, A.K. (2017). *Knowledge and passive adaptation to climate change: An example from Indian farmers*. *Climate Risk Management*, **16**:195-207.
- UNDP-UNEP (2011). *Mainstreaming climate change adaptation into development planning. A guide for practitioners*. UNDP-UNEP Poverty-Environment Facility, Nairobi, Kenya.

Different Developmental Programmes under the Critical Domains of Rural Development

Broad Thematic Group	Sub-Group	Category	Scheme/Programme	Launch Year	Ministry/ Department
Rural Livelihood Security	Rural Employment	Rural Employment	Mahatma Gandhi National Rural Employment Guarantee Scheme	February, 2006	Ministry of Rural Development (Department of Rural Development)
			National Rural livelihood Mission: Ajeevika	June, 2011	Ministry of Rural Development (Department of Rural Development)
			Prime Minister's Employment Generation Programme	2008-09	Ministry of Micro, Small & Medium Enterprises
	Social Security and Welfare	Pension	National Social Assistance Programme	August, 1995	Ministry of Rural Development (Department of Rural Development)
			<i>Atal Pension Yojana</i>	May, 2015	Ministry of Finance
			<i>Varishtha Pension Bima Yojana</i>	July, 2003	Ministry of Finance
	Insurance		<i>Rashtriya Swasthya Bima Yojana</i>	2007	Ministry of Health & Family Welfare
			<i>Aam Aadmi Bima Yojana</i>	October, 2007	Ministry of Finance
			<i>Pradhan Mantri Jeevan Jyoti Bima Yojana</i>	May, 2015	Ministry of Finance
			<i>Pradhan Mantri Suraksha Bima Yojana</i>	May, 2015	Ministry of Finance
	Financial Inclusion		<i>Pradhan Mantri Jan-Dhan Yojana</i>	August, 2014	Ministry of Finance
	Rural Infrastructure Development	Rural Road Connectivity	<i>Pradhan Mantri Gram Sadak Yojana</i>	December, 2000	Ministry of Rural Development (Department of Rural Development)
		Rural Housing	<i>Indira Awas Yojana</i>	January, 1996	Ministry of Rural Development (Department of Rural Development)
		Rural Electrification	<i>Deen Dayal Upadhyaya Gram Jyoti Yojana</i>	2015	Ministry of Power
			Remote Village Electrification Programme	2003-04	Ministry of New and Renewable Resources

Overall Asset Creation	Shyama Prasad Mukherji Rurban Mission	July, 2014	Ministry of Rural Development (Department of Rural Development)
	Members of Parliament Local Area Development Scheme	1993	Ministry of Statistics and Programme Implementation
Rural Governance	<i>Rajiv Gandhi Panchayat Sashaktikaran Abhiyan</i>	2013	Ministry of Panchayati Raj
	Backward Region Grant Fund	2007	Ministry of Panchayati Raj
Skill & Entrepreneurship Development	Skill Development Mission	2015	Ministry of Skill development & Entrepreneurship
	<i>Pradhan Mantri Kaushal Vikas Yojana</i>	July, 2015	Ministry of Skill development & Entrepreneurship
	Vocational Training in Tribal Areas	1992-93	Ministry of Tribal Affairs
	Skill Development Initiative for Minority	2013-14	Ministry of Minority Affairs
Encouraging Entrepreneurship Culture	Promotional Services Institutions and Programme	Continuing	Ministry of Micro, Small and Medium Enterprises
	Assistance to Training Institutes	Continuing	Ministry of Micro, Small and Medium Enterprises
	Aspire : Scheme for promotion of Innovation, Entrepreneurship and Agro-Industry	2015	Ministry of Micro, Small and Medium Enterprises
	Credit Enhancement Guarantee Scheme for Young and Start-Up Entrepreneurs belonging to Scheduled Castes	2014	Ministry of Social Justice and Empowerment
	Venture Capital Fund for Scheduled Caste Entrepreneurs	January, 2015	Ministry of Social Justice and Empowerment
	Scheme of Fund for Regeneration of Traditional Industries	2005-06	Ministry of Micro, Small and Medium Enterprises
	Credit Linked Capital Subsidy Scheme	2000	Ministry of Micro, Small and Medium Enterprises

National Manufacturing Competitiveness Programme	2005	Ministry of Micro, Small and Medium Enterprises
Credit Guarantee scheme	2000	Ministry of Micro, Small and Medium Enterprises
Bank Credit Facilitation	Continuing	Ministry of Micro, Small and Medium Enterprises
Performance & Credit Rating Scheme	2005	Ministry of Micro, Small and Medium Enterprises
Marketing Assistance Scheme	2007	Ministry of Micro, Small and Medium Enterprises
Micro & Small Enterprises Cluster Development Programme	1998/2010 (Restructured form)	Ministry of Micro, Small and Medium Enterprises
Raw Material Assistance Scheme	Continuing	Ministry of Micro, Small and Medium Enterprises
<i>Coir Vikas Yojana</i>	Continuing	Ministry of Micro, Small and Medium Enterprises
<i>Coir Udyami Yojana</i>	Continuing	Ministry of Micro, Small and Medium Enterprises
<i>Rajiv Gandhi Udyami Mitra Yojana</i>	2008	Ministry of Micro, Small and Medium Enterprises
<i>Pradhan Mantri MUDRA Yojana</i>	April, 2015	Ministry of Finance
Stand up India scheme	April, 2016	Ministry of Finance
National Rural Health Mission	April, 2005	Ministry of Health & Family Welfare
Health Care & Management		
Rural Drinking Water Supply		
National Rural Drinking Water Programme	April, 2009	Ministry of Drinking Water and Sanitation
Rural Sanitation & Hygiene		
<i>Swachh Bharat Mission (Gramin)</i>	October, 2014	Ministry of Drinking Water and Sanitation

Emergency Relief	System Strengthening including Emergency Medical Relief/Disaster Management	Continuing	Ministry of Health & Family Welfare
	National Calamity Contingency Fund /	1990	Ministry of Finance
	Grant in aid to state disaster relief fund	Continuing	Ministry of Finance
Elementary Education	<i>Sarva Shiksha Abhiyan</i>	2000-01	Ministry of Human Resource Development (Department of School Education and Literacy)
	National Programme of Mid-Day Meal	August, 1995	Ministry of Human Resource Development (Department of School Education and Literacy)
	Scheme for Infrastructure Development Private aided/ unaided Minority Institutes (Secondary/Senior Secondary Schools)	X Plan	Ministry of Human Resource Development (Department of School Education and Literacy)
	Scheme for providing Quality Education in Madrasas	XI Plan	Ministry of Human Resource Development (Department of School Education and Literacy)
Secondary Education	Ashram Schools in Tribal Sub Plan Area	1990-91	Ministry of Tribal Affairs
	<i>Rashtriya Madhyamik Shiksha Abhiyan</i>	March, 2009	Ministry of Human Resource Development (Department of School Education and Literacy)
	National Means Cum-Merit Scholarship Scheme	May, 2008	Ministry of Human Resource Development (Department of School Education and Literacy)
	National Scheme of Incentive to Girls for Secondary Education	May, 2008	Ministry of Human Resource Development (Department of School Education and Literacy)
	Pre-Matric Scholarship for Scheduled Tribe Students Studying in Classes IX&X	July, 2012	Ministry of Tribal Affairs
	Scheme of Post Matric Scholarships, Book Banks and Upgradation of Merit	1944-45	Ministry of Tribal Affairs

	Post-Matric Scholarship for Scheduled Caste Students	1994	Ministry of Social Justice and Empowerment
	Post-Matric Scholarship to the OBC for studies in India	1998-99	Ministry of Social Justice and Empowerment
	Pre-Matric Scholarship to the OBCs for studies in India	1998-99	Ministry of Social Justice and Empowerment
	Pre-Matric Scholarship for SC students studying in IX and X	July, 2012	Ministry of Social Justice and Empowerment
	Pre-matric scholarship for minorities	2008	Ministry of Minority Affairs
	Post-matric scholarships for minority	2007	Ministry of Minority Affairs
Higher Education	<i>Rashtriya Uchchaitar Shiksha Abhiyan</i>	2013	Ministry of Human Resource Development (Department of Higher Education)
	Merit-cum Means Scholarship Scheme	2007	Ministry of Minority Affairs
Adult Education	<i>Saakshar Bharat</i>	September, 2009	Ministry of Human Resource Development (Department of School Education and Literacy)
Women Empowerment and Child Development & Protection	Integrated Child Protection Scheme	2009-10	Ministry of Women and Child Development
	Integrated Child Development Services	October, 1975	Ministry of Women and Child Development
	National Child Labour Project	1987	Ministry of Labour & Employment
Women Empowerment, Development & Protection	<i>Beti Bachao Beti Padhao</i>	2015	Ministry of Women and Child Development
	Rajiv Gandhi Scheme for Empowerment of Adolescent Girls: SABLA	2011	Ministry of Women and Child Development
	Support to Training and Employment Programme for Women	1986-87	Ministry of Women and Child Development

	<i>Indira Gandhi Matritva Sahyog Yojana</i>	2010-11	Ministry of Women and Child Development
	National Mission for Empowerment of Women	March, 2010	Ministry of Women and Child Development
	Swadhar –A Scheme for Women in Difficult Circumstances	2001-02	Ministry of Women and Child Development
	Strengthening of Education among ST Girls in Low Literacy Districts	1993-94	Ministry of Tribal Affairs
	Scheme for Leadership Development of Minority Women : <i>Nai Roshni</i>	2012-13	Ministry of Minority Affairs
	<i>Saansad Adarsh Gram Yojana</i>	October, 2014	Ministry of Rural Development (Department of Rural Development)
	<i>Van Bandhu Kalyan Yojna</i>	2014-15	Ministry of Tribal Affairs
	Scheme for Development of Particularly Vulnerable Tribal Groups	April, 2008	Ministry of Tribal Affairs
	<i>Pradhan Mantri Adarsh Gram Yojana</i>	2009-10	Ministry of Social Justice and Empowerment
	Multi-sectoral Development Programme	2008-09	Ministry of Minority Affairs
	Groundwater Management and Regulation Scheme	XII Plan	Ministry of Water Resources, River Development & Ganga Rejuvenation
	National River Conservation Plan	1995	Ministry of Environment, Forest and Climate Change
	National Plan for Conservation of Aquatic Eco-system	2013	Ministry of Environment, Forest and Climate Change
	<i>Namami Gange</i>	2014	Ministry of Water Resources, River Development & Ganga Rejuvenation
Natural Resource Management	Water Management and Soil Conservation		
	River & Lake Conservation & Management		
	Holistic Development		
	Holistic Development		

Creation of Watershed & Irrigation Potential	Pradhan Mantri Krishi Sinchayee Yojana	1997 / 2014 (Restructured form)	Ministry of Water Resources, River Development & Ganga Rejuvenation
	1. Accelerated Irrigation & Flood Management Programme	2010	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	2. National Mission on Micro Irrigation / On Farm Management	February, 2009	Ministry of Rural Development (Department of Land Resources)
Integrated Approach	3. Integrated Watershed Management Programme	XII Plan	Ministry of Water Resources, River Development & Ganga Rejuvenation
	National Water Mission under NAPCC	2008	Ministry of Water Resources, River Development & Ganga Rejuvenation
	National Afforestation Programme	2000-02	Ministry of Environment, Forest and Climate Change
Forest and Biodiversity Conservation	Forest Protection		
	Intensification of Forest Management Scheme	X Plan	Ministry of Environment, Forest and Climate Change
	Green India Mission	2008	Ministry of Environment, Forest and Climate Change
Wildlife Conservation and Protection	Biosphere Reserve scheme	1986	Ministry of Environment, Forest and Climate Change
	Integrated Development of Wildlife Habitat	XI Plan	Ministry of Environment, Forest and Climate Change
	National Coastal Management Programme	1991	Ministry of Environment, Forest and Climate Change
Coastal Management	Integrated Coastal and Marine Area Management	1998	Ministry of Earth Sciences

Productivity Enhancement and Production Augmentation	Multi-hazard Vulnerability Mapping	XIII Plan	Ministry of Earth Sciences
Soil Health, Manures & Fertilizer	National Project on Management of Soil Health and Fertility	2008-09	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
Integrated Nutrient Management	Soil Health Card	2014-15	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
Development of Organic Farming	National Project on Promotion of Organic Farming	2004	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	<i>Pampaparagat Krishi Vikas Yojana</i>	2015	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
Improving Input Supply and Service delivery System	National Mission on Agricultural Extension & Technology : Sub Mission on Seed and Planting Material	2014-15 (Restructured form)	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
Agricultural Mechanization & Technology	National Mission on Agricultural Extension & Technology: Sub Mission on Agricultural Mechanization	2014-15 (Restructured form)	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
Fertilizer Subsidy & Investment	Nutrient Based Subsidy Policy	2010	Ministry of Chemicals & Fertilizers (Department of Fertilizers)
	Urea Subsidy	1977	Ministry of Chemicals & Fertilizers (Department of Fertilizers)
Plant Protection	National Mission on Agricultural Extension & Technology: Sub Mission on Plant Protection and Plant Quarantine	2014-15 (Restructured form)	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)

Animal Husbandry and Fisheries	Livestock and Fishery Improvement and Management	National Livestock Mission	2014	Ministry of Agriculture and Farmers' Welfare (Department of Animal Husbandry, Dairying & Fisheries)
		National Programme for Bovine Breeding and Dairy Development	2014 (Restructured form)	Ministry of Agriculture and Farmers' Welfare (Department of Animal Husbandry, Dairying & Fisheries)
		Development of Inland Fisheries & Aquaculture	1973-74	Ministry of Agriculture and Farmers' Welfare (Department of Animal Husbandry, Dairying & Fisheries)
		Development of Marine fisheries, Infrastructure & post-harvest operations	XPlan	Ministry of Agriculture and Farmers' Welfare (Department of Animal Husbandry, Dairying & Fisheries)
		National Scheme of Welfare of Fisherman	1991-92	Ministry of Agriculture and Farmers' Welfare (Department of Animal Husbandry, Dairying & Fisheries)
	Dairy Development	Dairy Entrepreneurship Development Scheme	2010	Ministry of Agriculture and Farmers' Welfare (Department of Animal Husbandry, Dairying & Fisheries)
		National Dairy Plan	2012	Ministry of Agriculture and Farmers' Welfare (Department of Animal Husbandry, Dairying & Fisheries)
Cooperatives	Cooperatives	Integrated Scheme on Agricultural Cooperation	2014-15 (Restructured form)	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
Integrated Development	Improved Crop Production	National Food Security Mission	2007-08	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
		<i>Rashtriya Krishi Vikas Yojana</i>	2007-08	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)

	Macro Management Agriculture	2000	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	Rainfed Area Development and Climate Change	2011-12	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	Mission for Integrated Development of Horticulture	2014-15 (Restructured form)	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	National Mission on Oilseeds and Oil Palm	2014-15 (Restructured form)	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	Investment in Debentures of State Land Development Banks (SLDBs) State Cooperative Agriculture & Rural Development Banks	1966-67	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	Interest Subvention Scheme for Short Term Crop Loans	2006-07	Ministry of Finance
	National Agricultural Insurance Scheme	1999-2000	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	Modified National Agricultural Insurance Scheme	2010-11	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	Weather Based Crop Insurance Scheme	2007-08	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	Coconut Palm Insurance Scheme	2009-10	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
Risk Financing	Insurance and Credit Support		

		<i>Pradhan Mantri Fasal Bima Yojana</i>			
Foodgrain Management	Procurement, Storage and Distribution	Procurement	Scheme of Decentralized Procurement of Foodgrains	1997-98	Ministry of Consumer Affairs, Food and Public Distribution (Department of Food & Public Distribution)
			Buffer Stock Policy	IV Plan	Ministry of Consumer Affairs, Food and Public Distribution (Department of Food & Public Distribution)
			Open Market Sale Scheme	Continuing	Ministry of Consumer Affairs, Food and Public Distribution (Department of Food & Public Distribution)
			Targeted Public Distribution System	1997	Ministry of Consumer Affairs, Food and Public Distribution (Department of Food & Public Distribution)
			Management of Sugar	Continuing	Ministry of Consumer Affairs, Food and Public Distribution (Department of Food & Public Distribution)
			Village Grain Bank Scheme	1996-97	Ministry of Consumer Affairs, Food and Public Distribution (Department of Food & Public Distribution)
			Strengthening PDS Operations	Continuing	Ministry of Consumer Affairs, Food and Public Distribution (Department of Food & Public Distribution)
			Storage & Warehousing	2008	Ministry of Consumer Affairs, Food and Public Distribution (Department of Food & Public Distribution)
			Marketing and Prices	2014-15 (April, 2016)	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)

	Integrated Scheme for Agricultural Marketing	2014-15	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
Price Support and Regulation	Price Stabilization Fund for Cereals and Vegetables	2014—15	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	Mechanism for Marketing of Minor Forest Produce (MFP) through Minimum Support Price (MSP) and Development of Value Chain for MFP	2013-14	Ministry of Tribal Affairs
	Minimum Support Prices	1966-67	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	Market Intervention Scheme	Continuing	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
	Fair and Remunerative Prices	2009-10	Ministry of Agriculture and Farmers' Welfare (Department of Agriculture Cooperation & Farmers' Welfare)
Food Processing	Mega Food Parks	2008	Ministry of Food Processing
	Upgradation/Improvement in Food Processing Capacity and Value Addition		
	Cold Chain Value Addition and Preservation Infrastructure	XI Plan	Ministry of Food Processing
	Scheme for Technology Upgradation, Establishment, Modernization of Food Processing Industries	IX plan	Ministry of Food Processing
	National Mission on Food Processing	2015	Ministry of Food Processing

Research & Extension	Climate Adaptation Centric Support	Climate Adaptation Centric Approach	National Adaptation Fund for Climate Change	August, 2015	Ministry of Environment, Forest and Climate Change
			National Innovations on Climate Resilient Agriculture	February, 2011	Ministry of Agriculture and Farmers' Welfare (Department of Agricultural Research and Education)
			Climate Change Programme	2008	Ministry of Science and Technology (Department of Science & technology)
	Information Dissemination	Agriculture Extension and Training	National Mission on Agricultural Extension & Technology: Sub Mission on Agriculture Extension	2014-15 (Restructured form)	Ministry of Agriculture and Farmers' Welfare (Department of Agricultural Research and Education)
			Biotechnology for Societal Development	1990	Ministry of Science and Technology (Department of Biotechnology)
			S&T Programmes For Socio-Economic Development	Continuing	Ministry of Science and Technology (Department of Science & technology)
			Special Component Plan For Scheduled Castes	Continuing	Ministry of Science and Technology (Department of Science & technology)
			Scheduled Tribe Sub-Plan	Continuing	Ministry of Science and Technology (Department of Science & technology)
		Early Warning System/ Forecast/ Modelling	Flood Forecasting	Continuing	Ministry of Water Resources, River Development & Ganga Rejuvenation
			Numerical Modelling of Weather & Climate	XII Plan	Ministry of Earth Sciences
			Agro-Meteorological Services Programme	Continuing	Ministry of Earth Sciences

Note: The term 'Continuing' has been used for the scheme/programme where year of introduction/launch was not available but was still in operation.

NIAP Publications

Policy Papers

17. Adhiguru, P., and C. Ramasamy. 2003. *Agricultural-based Interventions for Sustainable Nutritional Security*.
18. BIRTHAL, P.S. 2003. *Economic Potential of Biological Substitutes for Agrochemicals*.
19. Chand, R. 2003. *Government Intervention in Foodgrain Markets in the New Context*.
20. Mruthyunjaya, S. Pal, and R. Saxena. 2003. *Agricultural Research Priorities for South Asia*.
21. Dastagiri, M.B. 2004. *Demand and Supply Projections for Livestock Products in India*.
22. Bhowmick, B.C., B.C. Barah, S. Pandey, and N. Barthakur. 2005. *Changing Pattern of Rice Production Systems and Technology in Assam*.
23. Jha, D., and S. Kumar. 2006. *Research Resource Allocation in Indian Agriculture*.
24. Kumar, A. 2009. *India's Livestock Sector Trade: Opportunities and Challenges*.
25. Chand, R., P. Kumar, and S. Kumar. 2011. *Total Factor Productivity and Contribution of Research Investment to Agricultural Growth in India*.
26. Chand, R., S.S. Raju, S. Garg, and L.M. Pandey. 2011. *Instability and Regional Variation in Indian Agriculture*.
27. Raju, S.S., P. Shinoj, R. Chand, P.K. Joshi, P. Kumar, and S. Msangi. 2012. *Biofuels in India: Potential, Policy and Emerging Paradigms*.
28. Shinoj P., A. Kumar, S. Kumar, and R. Jain. 2014. *Commodity Outlook on Major Cereals in India*.
29. BIRTHAL, P.S., S. Kumar, D.S. Negi, and D. Roy. 2016. *The Impact of Information on Returns from Farming*.
30. BIRTHAL, P.S., D.S. Negi and D. Roy 2017. *Enhancing Farmers' Income: Who to Target and How?*
31. Saxena, R., N.P. Singh, Balaji S. J., Usha R. Ahuja and Deepika Joshi. 2017. *Strategy for Doubling Income of Farmers in India*.

Policy Briefs

26. Kumar, B.G. and K.K. Datta. 2008. *Tackling Avian Influenza, An Emerging Transboundary Disease*.
27. Beintema, N., P. Adhiguru, P.S. BIRTHAL, and A.K. Bawa. 2008. *Public Agricultural Research Investments: India in a Global Context*.
28. Chand, R. 2009. *Demand for Foodgrains During 11th Plan and Towards 2020*.
29. Shinoj, P. 2009. *India-ASEAN Trade in Agriculture: Retrospect and Prospect*.
30. BIRTHAL, P.S., and S. Kumar. 2009. *Conditions for the Success of Contract Farming in Smallholder Agriculture?*
31. Raju, S.S., and R. Chand. 2009. *Problems and Prospects in Agricultural Insurance in India*.
32. BIRTHAL, P.S., and P.K. Joshi. 2009. *Agriculture and Regional Disparities in India*.
33. Singh, H., and R. Chand. 2010. *The Seeds Bill, 2010: A Critical Appraisal*.
34. Kumar, S., P.A.L. Prasanna, and S. Wankhade. 2010. *Economic Benefits of Bt Brinjal-An Ex-Ante Assessment*.
35. Chand, R., A. Gulati, P. Shinoj and K. Ganguly. 2011. *Managing Food Inflation in India: Reforms and Policy Options*.
36. Shinoj, P., S.S. Raju, R. Chand, P. Kumar, and S. Msangi. 2011. *Biofuels in India: Future Challenges*.
37. Ramasundaram, P., A. Suresh, and R. Chand. 2011. *Maneuvering Technology for Surplus Extraction: The case of Bt Cotton in India*.
38. Chand, R., and J. Jumrani. 2013. *Food Security and Undernourishment in India: Assessment of Alternative Norms and the Income Effect*.
39. Chand, R., and P.S. BIRTHAL. 2014. *Buffer Stock Norms for Food grains during Twelfth Five Year Plan*.
40. Chand, R., and S.K. Srivastava. 2014. *Changing Structure of Rural Labour Market: Trends, Drivers and Implications for Agriculture*.
41. BIRTHAL, P.S., D.S. Negi, Md. Tajudding Khan, and S. Agarwal. 2015. *Is Indian Agriculture Becoming Resilient to Droughts? Evidence from Rice Production*.
42. Singh, N.P., and J.P. Bisen. 2017. *Goods and Services Tax: What it holds for Agricultural Sector?*



भा.कृ.अ.प.-राष्ट्रीय कृषि आर्थिकी एवम् नीति अनुसंधान संस्थान

ICAR – NATIONAL INSTITUTE OF AGRICULTURAL ECONOMICS AND POLICY RESEARCH

(Indian Council of Agricultural Research)

Dev Prakash Shastri Marg, Pusa, New Delhi-110 012, INDIA

Phone : 91-11-25847628, 25848731, Fax : 91-11-25842684 E-mail : director.niap@icar.gov.in

<http://www.ncap.res.in>