Climate Smart Agriculture towards Triple Win: Adaptation, Mitigation and Food Security

Discussion Paper 5

MANAGE-Centre for Agricultural Extension Innovations, Reforms, and Agripreneurship (CAEIRA)

National Institute of Agricultural Extension Management (MANAGE)
(An organisation of Ministry of Agriculture and Farmers' Welfare, Govt. of India)
Rajendranagar, Hyderabad – 500 030, Telangana State, India
www.manage.gov.in

Published by

National Institute of Agricultural Extension Management (MANAGE)
(An organisation of Ministry of Agriculture and Farmers' Welfare, Govt. of India)
Rajendranagar, Hyderabad - 500 030, Telangana State, India

About the Publication

The research report is based on the research conducted by Ms. Deepika Bhardwaj as MANAGE Intern under the MANAGE Internship Programme for Post Graduate students of Extension Education.

Authors

Ms. Deepika
MANAGE Intern and PhD Research Scholar
Punjab Agricultural University,
Ludhiana, Punjab, India
e-mail: deepika31bhardwaj@gmail.com

Dr. Suchiradipta Bhattacharjee
MANAGE Fellow, Centre for Agricultural Extension Innovations and Reforms
National Institute of Agricultural Extension Management (MANAGE)
Rajendranagar, Hyderabad, Telangana, India
e-mail: suchiradipta.b@manage.gov.in/ suchiradipta@hotmail.com

Dr. Saravanan Raj
Director (Agricultural Extension)
National Institute of Agricultural Extension Management (MANAGE)
Rajendranagar, Hyderabad, Telangana, India
e-mail: saravanan.raj@manage.gov.in/ saravananraj@hotmail.com

Layout Design

Ms. Niharika Lenka

Disclaimer

Correct citation: Deepika, Suchiradipta, B., and Saravanan, R. 2018. Climate Smart Agriculture towards Triple Win: Adaptation, Mitigation and Food Security. MANAGE Discussion Paper 5, MANAGE-Centre for Agricultural Extension Innovations, Reforms and Agripreneurship (CAEIRA), National Institute of Agricultural Extension Management, Hyderabad, India.

Director General's Message

Smt. V. Usha Rani, IAS
Director General, MANAGE

Climate is ever changing and the challenges of climate are making the farmers most vulnerable. While long-term strategies like developing alternative sources of energy and afforestation, etc. are very important, the immediate action has to be taken by Extension Machinery by giving the information of weather data and suitable varieties to him. There should be constant research on different crops and varieties which are suitable to the ever changing climate situation.

The intern Ms. Deepika under the guidance of Dr. Saravanan Raj, Director (Agricultural Extension), studied various ongoing initiatives of Government and also on the areas to be concentrated by the Policy makers to combat the climate change. The initiative also compares plan of action under NICRA and JICA project. I appreciate the good job done by Ms. Deepika and giving recommendations to various stakeholders. Ultimately to combat the situation, crops needs to be promoted, post-harvest losses to be minimized and food waste to be reduced. This would save natural resources like water which is a very important resource to be conserved in the changed climate scenario. "Agri-advisory services" giving personalized messages to farmers is the key to extension in the changed scenario as is brought out by the study.

09.04.2018

(V.Usha Rani)

Contents

List of Tables

List of Figures

Abbreviations

ADO	Agricultural Development Officer
AEO	Agricultural Extension Officer
AGN	African Group of Negotiators
AIC	Agriculture Insurance Scheme
APAARI	Asia Pacific Association of Agricultural Research Institutes
ATARI	Agriculture Technology Application Research Institute
CCAFS	Climate change, Agriculture and Food Security
CGIAR	Consultative Group of International Agricultural Research
CRIDA	Central Research Institute of Dryland Agriculture
CSA	Climate Smart Agriculture
DBT	Department of Bio Technology
FAO	Food and Agriculture Organization
GACSA	Global Alliance on Climate Smart Agriculture
GFRAS	Global Forum for Rural Advisory Services
GIS	Geographic Information System
HDO	Horticulture Development Officer
HEO	Horticulture Extension Officer
ICT	Information and Communication Technology
INDC	Intended Nationally Determined Contributions
IPCC	International Panel on Climate Change
IWMP	Integrated Watershed Management Programme
JICA	Japan International Co-operative Agency
KVA	Krishak Vikas Associations
KVK	Krishi Vigyan Kendra
MoD	Minutes of Discussions
NABARD	National Bank for Agriculture and Rural Development
NAFCC	National Adaptation Fund for Climate Change
NAPA	National Adaptation Programmes of Action
NAP	National Adaptation Plans
NAMA	National Appropriate Mitigation Actions
NAPCC	National Action Plan on Climate Change
NCOF	National Centre of Organic Farming
NGO	Non-Government Organization
NICRA	National Innovations in Climate Resilient Agriculture
NMSA	National Mission on Sustainable agriculture
PMFBY	Pradhan Mantri Fasal Bima Yojana
PMKSY	Pradhan Mantri Krishi Sinchai Yojana

PMU	Project Management Unit
RAD	Rainfed Area Development
RAS	Rural Advisory Services
RKVY	Rashtriya Krishi Vikas Yojana
SAU	State Agriculture University
SAPCC	State Action Plan on Climate Change
SAMETI	State Agriculture Management and Extension Training Institute
SCW	Soil Conservation
SDA	State Department of Agriculture
SHM	Soil Health Management
SMS	Subject Matter Specialist
STL	Soil Testing Laboratories
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VCRMC	Village Climate Resilient Management Committe

Abstract

The study "Climate Smart Agriculture Towards a Triple Win: Adaptation, Mitigation and Food Security" was undertaken with the objectives to get a comprehensive assay of all the stakeholders involved in climate smart agriculture programmes and the assessment of barriers and incentives while adopting climate smart agricultural practices by all the stakeholders involved. The research was taken up in the vulnerable districts, Hamirpur and Bilaspur of Himachal Pradesh where different stakeholders consisted the sample size, identified through snowball sampling. A semi-structured interview schedule was prepared for stakeholder mapping and analysis. The findings of the study revealed that the Climate Smart Agriculture (CSA) programmes viz., National Innovations in Climate Resilient Agriculture (NICRA), National Mission on Sustainable Agriculture (NMSA), Pradhan Mantri Krishi Sinchai Yojana (PMKSY), Pradhan Mantri Fasal Bima Yojana (PMFBY) and Himachal Pradesh Crop Diversification Project (HPCDP) have been identified in the selected districts in which state agriculture university, state department of agriculture and other line departments, Zonal Research Stations (ZRS), soil conservation wing, soil testing labs, development officers, agricultural extension officers (AEOs), Krishak Vikas Associations (KVAs), farmers, groups, input dealers and traders, self-help groups and the farmers have been collaboratively working under these programmes. Different extension activities viz., demonstrations and trainings have been organized at village level and institutional level on natural resource management, crop production, integrated pest management, livestock production etc., to make farmers more climate smart. On mapping of the stakeholders based on their power and interest, it was found that state department of agriculture and other line departments, development officers at district level and research organisations had high power and low interest while the stakeholders at block (AEOs and KVAs) and village level (SHGs and farmers) were categorized with low power and high interest. From relational analysis of the stakeholders by actor-linkage matrix, it was revealed that the farmers and state departments have weak collaboration with input dealers. Various agro-advisories and weather forecasting messages have been given to the beneficiaries through mkisan portal, personal contact method, mass media, etc. Inaccessibility to good quality inputs, lack of space on the small land holdings for installing water harvesting structures and micro irrigation projects, lack of marketing facilities, lack of access to credit facilities were identified as the major barriers, while success stories and best farmer awards were identified as incentives.

Executive Summary

High population growth accompanied by resource degradation, rising poverty levels and food insecurity make India extremely vulnerable to the impacts of climate change and weather variability. Several reasons have been reported for this declining trend of annual GDP growth in Indian economy. Out of the various reasons, changes in the climatic conditions and weather variability plays an important role in ensuring food security of the nation. Agriculture and allied sectors are found to be most sensitive to climate change. Any degree of change in weather parameters, i.e., temperature, rainfall and relative humidity which poses a significant impact on agriculture and allied sector's productivity, which is an important measure of socio-economic development of the farmers and hence, food security of the nation. In response to this, a series of policies and plans have been designed under the United Nations Framework Convention on Climate Change (UNFCCC) and Consultative Group of International Agricultural research (CGIAR) for linking international climate change commitments to concrete on action for mitigation and adaptation at the country level viz. Climate Change, Agriculture and Food Security (CCAFS), National Adaptation Programmes of Action (NAPAs), National Adaptation Plans (NAPs) and Nationally Appropriate Mitigation Actions (NAMAs) which focus on the activities that address climate change, either through adaptation or mitigation. In a review of this, Food and Agriculture Organisation (FAO) coined the term Climate Smart Agriculture (CSA) which is an approach that comprehends various agricultural adaptation and mitigation practices, policies, institutions and financing to fetch tangible welfare to the farmers. But, policies are prepared on the basis of existing technologies and knowledge from top to middle level while vacuum at the bottom still remains unaddressed. Only a few chosen are benefited while the majority are left out of the development process. So, various gaps exist in the same villages/taluks/blocks with the same resources. So, to understand which stakeholders are involved in delivery of climate smart agricultural technologies and how ther are working, a comprehensive assay of stakeholders involved in Climate Smart Agriculture of the selected region was studied through literature and field survey to identify roles, actions, existing policy and institutional framework, funding mechanism, linkages, information flow, insurance packages, major institutional actors and their current priorities as well as the critical areas that are not being addressed. The study also attempted to find out the various determinants i.e., barriers and incentives for the adaptation of Climate Smart Agriculture. The research was taken up in the state of Himachal Pradesh in which Hamirpur and Bilaspur were selected randomly from the top five vulnerable districts as per the report given by the State Action Plan on Climate Change. Different stakeholders consisted the sample size of the present study identified by snowball sampling. Both qualitative and quantitative data were collected in the selected areas of the target population. A semi-structured interview schedule was prepared to do the stakeholder mapping and analysis. The CSA programmes viz., National Innovations in Climate Resilient Agriculture (NICRA), National Mission on Sustainable Agriculture (NMSA), Pradhan Mantri Krishi Sinchai Yojana (PMKSY), Pradhan Mantri Fasal Bima Yojana (PMFBY) and Himachal Pradesh Crop Diversification Project (HPCDP) have been identified in both the districts Bilaspur and Hamirpur of the State Himachal Pradesh. Different stakeholders viz., State agriculture university, state department of agriculture and other line departments, Zonal Research Stations (ZRS), soil conservation wing,

soil testing labs, development officers (ADOs, SMSs), extension officers (AEOs, VLEWs), Krishak Vikas Associations (KVSs), farmers' groups, input dealers and traders, self-help groups and ultimately the farmers have been collaboratively working. Under these programmes, demonstrations and trainings on natural resource management, crop production, insect pest management, organic farming, etc., have been organized at either village level or institutional level. Other activities like exposure visits have also been carried out by implementing agencies with the collaboration of 3rd party, i.e., State Agricultural University (SAU) and Agricultural Technology Application Research Institute (ATARI) on the farmers' fields to monitor and evaluate the activities under CSA programmes. Exposure visits for the farmers are also organized to the progressive farms and NGOs which are doing good work in CSA programmes. Findings revealed that state level and district level stakeholders lie in high power area of power-interest grid and have strong relationship in execution and management of all the resources and activities under CSA projects while the stakeholders of village and block level have high interest in identification and solving of the weather variability related issues with strong collaboration among each other. The services like distribution of inputs i.e., seeds, pesticides, seedlings, construction of water harvesting structures, farm implements, crop insurance etc., and organizing extension activities have been provided to the farmers under the CSA programmes for adaptation and mitigation of climate change effects. Agro-advisories viz., sowing time, irrigation time, availability of inputs, weather forecasting messages have been given to the beneficiaries through m-kisan portal, personal contact method by extension officers, mobile phones, newspaper, progressive farmers, neighbors etc. Inaccessibility to good quality input, lack of space on the small land holdings for installing water harvesting structures and micro irrigation projects, lack of marketing facilities, lack of access to credit facilities etc. were the barriers in successful adaptation of CSA practices in both the districts. Success stories and best farmers awards under various CSA programmes served as incentives for the farmers. CSA programmes provide site specific nutrient management, precision water management (micro-irrigation), seed/fodder banks, value added weather forecasts, skill development, ICT based advisories and capacity development and knowledge sharing.

Introduction

Trends in Agriculture – Global and Indian scenario

Agriculture plays a critical role in every nation's economy. Agriculture is the backbone of the economic system of every nation. In addition to providing food and raw material, it also provides employment opportunities to very large percentage of the population. Agricultural contribution in world's economy from last six years (2011-2016) has been given in Fig 1(a) which indicates that agriculture's contribution to world's GDP has decreased annually except in 2012 where it contributed to 4.94 per cent to the world's economy. There is also the declining trend of agricultural and allied activities' share in total Indian GDP (Fig 1b). Several reasons have been reported for this declining trend of annual GDP growth in both world and Indian economy, i.e., decreased land holdings, green revolution, declined ground water availability, irregular finance and market conditions, climate change and weather variability, etc. One of the above factors, i.e., change in climatic conditions and weather variability play an important role in ensuring food security of the world and Indian economy. Agriculture and allied sectors are found to be most sensitive to climate change and any degree of change in weather parameters, i.e., temperature, rainfall and relative humidity pose a significant impact on agricultural and allied sectors' productivity which is an important measure of food security of the nation. Food security is linked both directly and indirectly to climate change. Any alteration in the climatic parameters such as temperature and humidity which govern crop growth will have a direct impact on the quantity of food produced. Indirect linkage pertains to catastrophic events such as flood and drought which are projected to multiply as a consequence of climate change leading to huge crop loss and leaving large patches of arable land unfit for cultivation and hence threatening food security.

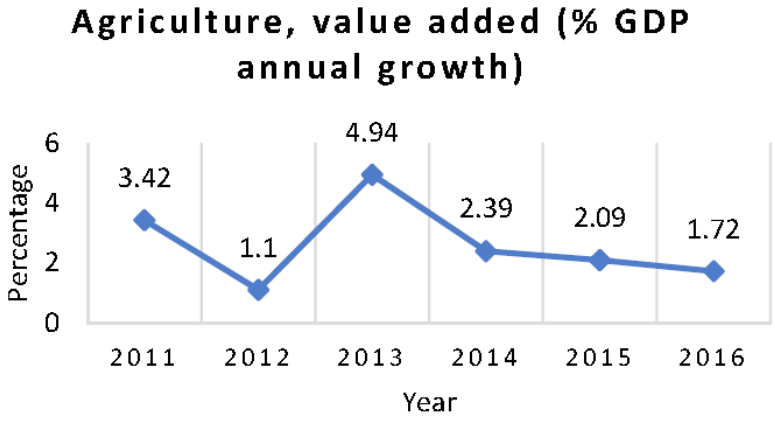

Figure 1a: World's GDP Annual Growth
Source: https://goo.gl/uhPx76

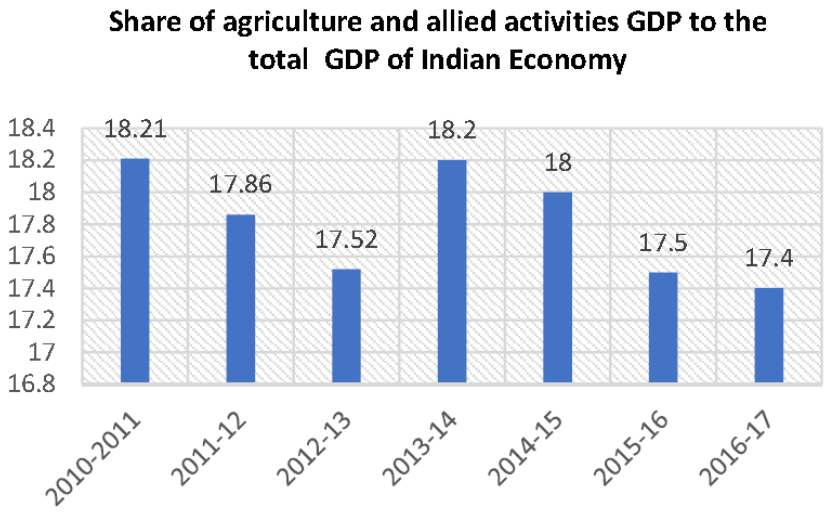

Figure 1b: Indian's GDP annual growth Source: https://goo.gl/xk8PLkSource: https://goo.gl/uhPx76

The net impact of food security will depend on the exposure to global climate change and the capacity to cope with and recover from this erratic climate change. On a global level, increasingly unpredictable weather patterns will lead to fall in agricultural production and higher food prices, leading to food insecurity.

Impact of Climate Change and Weather Variability on World's and Indian Agriculture

Weather variability took place at a time when there was increasing demand for food, feed, fiber and fuel which had the potential to irreversibly damage the natural resource base on which agriculture depends (Anonymous, 2009; Anonymous, 2013). Climate change and weather variability have emerged as one of the greatest environmental challenges the world is facing today. International Panel on Climate Change defines climate change as a change in the state of the climate that can be identified by changes in the mean and variability of the properties that persist for an extended period, typically decades or longer. Seasonal change profoundly affects the balance of life in ecosystems and essential human activities including agriculture and irrigation. Three main ways have been found in which weather variability affects the agriculture sector. Firstly, change in temperature and precipitation leads to decrease in water availability. Secondly, changes in temperature have a direct effect on crop yields as these crops have different optimal growing conditions. Thirdly, higher and lower temperatures shorten dormant periods, speed up pest and disease growth and change the dynamics of their populations and their resistance which badly affect the crop production and this leads to increase in number of pesticide sprays which ultimately increase the expenditure involved to get the optimum productivity (Anonymous, 2011). Thus, weather and climate variations affect the plant growth and development at their critical growth stages which reduce yield significantly. So, it can be concluded that weather variability and climate change greatly influence the agricultural productivity in any region as productivity is being regulated by prevailing weather and climate through temperature, rainfall, relative humidity, light intensity, etc. of that area (Hundal and Kaur, 2007; Brown and Funk, 2008).

Agriculture is a very crucial sector that may reduce poverty in several ways - by increasing crop productivity, by creating more employment opportunities, and by improving the level of food security. Indian agriculture being a gamble of monsoons, crop yields continue to be climate sensitive and the fluctuations in temperature and rainfall pattern adversely affect crops productivity, thus threatening food security in India. It was found that temperature above threshold would harm the crops in terms of low germination, scorching of seedlings and desiccation of seedlings. With 1% increase in temperature annually, loss in wheat yield amounted to Rs. 4180/- to the net revenue per annum (Iizumi and Ramankutty 2015). Weather variability and climate change had direct impacts through changes in average temperatures, floods, droughts, and fluctuating relative humidity on agriculture production which affected the markets for goods, services and natural resource inputs important to production. In southern states of India, there was increase in the frequency of heavy rainfall events. A negative impact was found on grain production due to

these uneven rainfall events which ultimately decreased region's economy. Under conditions of North India, various weather stresses and its impacts have been found in wheat crop. The exposure was found to be a 50C increase in temperature at sowing stage and 1-20C increase in mean temperature at reproductive stage in wheat crop. Due to this exposure, there was a delay in the duration of wheat crop by 7 days which in turn reduced the yield by 5q/ha (Rao et al., 2015).

Climate change is likely to have a direct impact on food production across the globe. World agriculture faces a serious decline within this century due to fluctuations in variability of weather parameters. Overall, agricultural productivity for the entire world is projected to decline between 3 and 16% by 2080. India's agriculture is more dependent on monsoon and any change in monsoon trend drastically affects agriculture. In the Indo-Gangetic Plain, these pre-monsoon changes will primarily affect the wheat crop (>0.5°C increase in time slice 2010-2039 according to. In the states of Jharkhand, Odisha and Chhattisgarh alone, rice production losses during severe droughts average about 40% of total production, with an estimated value of $800 million. Increase in CO2 to 550 ppm increases yields of rice, wheat, legumes and oilseeds by 10-20%. A 1oC increase in temperature may reduce yields of wheat, soybean, mustard, groundnut, and potato by 3-7%. Productivity of most crops are likely to decrease only marginally by 2020 but by 10-40% by 2100 due to increases in temperature, rainfall variability, and decreases in irrigation water. The major impacts of climate change will be on rain fed or un-irrigated crops, which are cultivated in nearly 60% of cropland. A temperature rise by 0.5oC in winter temperature is projected to reduce rain fed wheat yield by 0.45 tonnes per hectare in India (Fussel, 2007). Indian agriculture at present is facing the difficulties of stagnating productivity, net sown range, decreasing land quality, decreasing per capita, accessibility, and developing environmental challenge and weather variability. Any changes in climate factors like temperature, precipitation, carbon dioxide concentration, changes in soil moisture will affect agriculture. Crop production which is vital to global food security, is being affected by climate change in all over the world. Precipitation will affect the frequency of extreme climatic events such as droughts and flooding. Higher temperatures may affect yields in a negative way and favor the growth of weeds and the proliferation of crop pests. With global warming, rainfall levels are expected to decline in many places and to occur in more intense events and evaporation and transpiration rates are projected to increase which reduce the availability of soil moisture for plant growth. In medium to long term, climate change will affect water resources and reduce the availability or reliability of water supplies in many places already subjected to water scarcity. Climate change has already affected the agriculture sectors in many parts of the world, and its impact will be amplified in the years and decades ahead. These changes will have direct effects on agricultural production which will have economic and social consequences and finally impacts on food security.

Innovation: The key to Farming System Adaptation

Endangered food security of the world and the nation due to climate change and its adverse impacts have been considered as the biggest challenges for all the stakeholders involved viz.,

public sectors, private sectors, research institutions, policy makers, etc. Addressing the new challenges posed by climate change will require innovations in farming systems. Innovations happen when individuals and groups adopt new ideas, technologies or processes which, when successful, spread through communities and societies. The process is complex, involving many actors, and it cannot function in a vacuum. It is furthered by the presence of an effective innovation system. An agricultural innovation system includes the general enabling, economic and institutional environment required by all farmers. Other key components are research and advisory services and effective agricultural producers' organizations. Innovation often builds on and adjusts local knowledge and traditional systems, in combination with new sources of knowledge from formal research systems (FAO, 2014).

Summary of climate change Impacts on Agriculture

- Increased frequency and intensity of extreme climate events such as heat waves, droughts and floods, leading to loss of agricultural infrastructure and livelihoods.
- Decrease in fresh water resources, leading to water scarcity in arable areas.
- Sea-level rise and coastal flooding, leading to salinization of land and water, and risks to fisheries and aquaculture.
- Temperature increase and water scarcity affecting plant and animal physiology and productivity.
- Detrimental effects of elevated tropospheric ozone on crop yields.
- Changes in plant, livestock and fish diseases and in pest species.
- Damage to forestry, livestock, fisheries and aquaculture
- Source: Food and Agriculture Organisation (FAO, 2014).

Agricultural emissions are expected to grow along with food demand, which is driven by population and income growth and associated changes in diets towards more animal-source products. Agriculture can contribute to mitigation by decoupling its production increases from its emission increases through reductions in emission intensity (which is the quantity of GHGs generated per unit of output) (Rao et al., 2013). This, in turn, can be complemented by actions that reduce food losses and waste and foster changes in food consumption patterns. The agriculture sector, particularly forestry, has a unique potential to act as carbon sinks by absorbing CO2 and sequestering carbon in biomass and soil. At present, however, deforestation is a major source of emissions, and unsustainable farming practices continue to deplete the Earth's stock of soil organic carbon. Tapping into the carbon sequestration potential of forests and agricultural lands will depend on biophysical conditions, technical options and policies (Newaj et al., 2015; Bayala et al., 2016).

Origin of Climate Smart Agriculture

As the importance of climate change and its impact has gained increasing recognition in the development of communities, organizations, research institutions, etc., understanding the key

weather constraints and how they are affected by climate change and weather variability is an important first step in determining the type of support that the farming communities will need (Anderson et al., 2016; Parikh and Parikh, 2002; Neufeldt et al., 2013; Dinesh et al., 2015). In view of this, various adaptation practices for building resilience to climate change and weather variability will contribute to climate change mitigation. Those options will need to be enabled and supported by appropriate policies, institutional frameworks and investment finance mechanisms. Many of these are important for agricultural development in general, but become even more necessary when addressing climate change. Existing policy frameworks need to be modified to integrate climate change concerns. To address agriculture and food security through mitigation and adaptation they need to encompass land and water management, disaster risk management, social protection, and research and development (Anderson et al., 2016; Aberman et al., 2011; Houghton 2004; Carfee-Morlot et al., 2003).

Many countries have designed broad climate change policies and strategies, which establish overall objectives and targets that reflect the relative importance of various sectors in their economies, as well as their national priorities (Hall et al., 2004). However, as yet, few have spelled out detailed action plans to achieve climate targets. In response to this, many countries proposed policy actions in relation to agriculture and land use in their Intended Nationally Determined Contributions (INDCs) under the United Nations Framework Convention on Climate Change (UNFCCC). As of 31

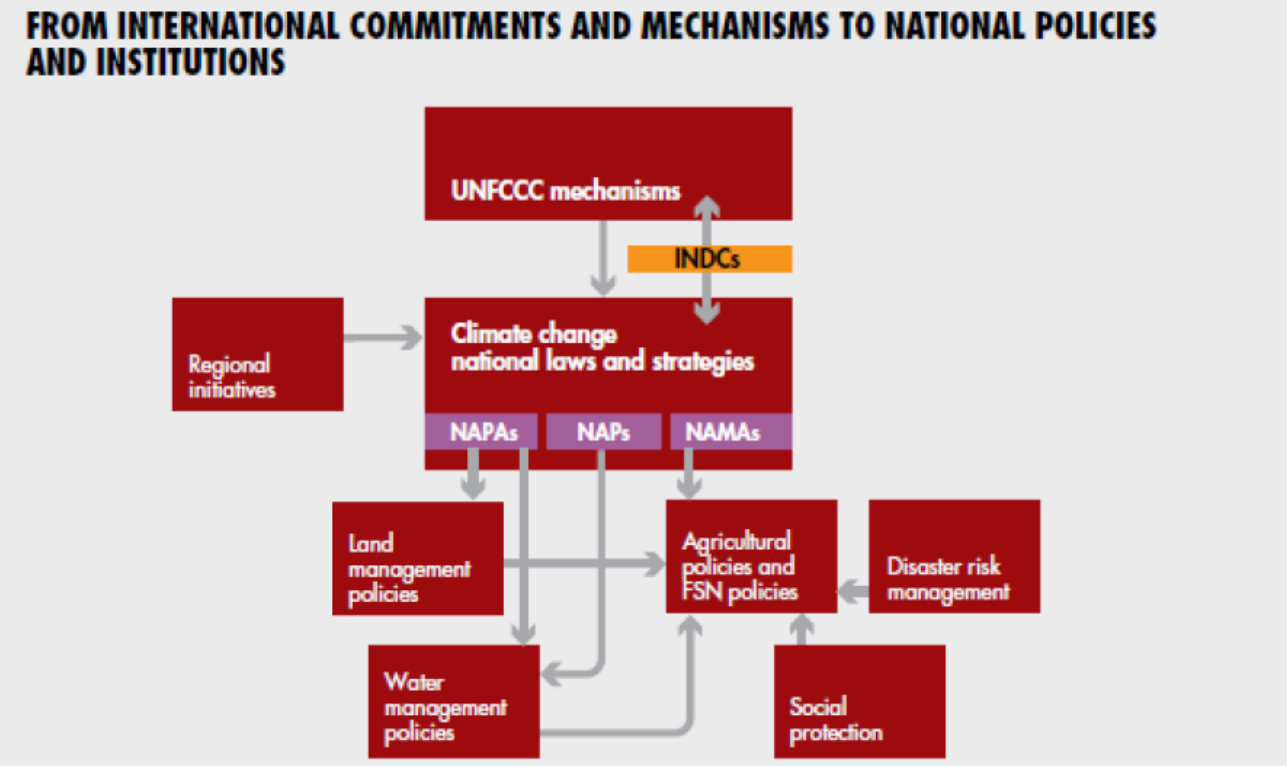

Figure 1 (c) Climate Change policies and strategies (Source: FAO, 2016)

March 2016, INDCs had been submitted to the UNFCCC by 188 countries. A series of instruments have been designed under the UNFCCC for linking international climate change commitments to concrete action for mitigation and adaptation at the country level viz., National Adaptation

Programmes of Action (NAPAs), National Adaptation Plans (NAPs) and National Appropriate Mitigation Actions (NAMAs) (Heltberg and Bonch-Osmolovskiy, 2011; Lipper et al., 2014; Meinzen et al., 2012; Nelson et al., 2010; Mutoko et al., 2015). These three instruments focus on the actions that address climate change, either through adaptation or mitigation. To mainstream the climate change and its impacts, international and national financial institutions begun to develop specific approaches, tools and protocols to integrate climate change considerations into planning and implementation. According to World Bank (2015) five voluntary principles to mainstream climate action within financial institutions are:

- Commit to climate strategies
- Manage climate risks
- Promote climate smart agriculture
- Improve climate performance
- Account for climate action

Table 1: CCAFS Plan of Work

Region	Countries	Priorities for 2015
East Africa	Ethiopia Kenya Tanzania Uganda	• Decision tools and business models for scaling out CSA • Promote the science-policy dialogues on National Adaptation plans in Kenya and Uganda
West Africa	Burkina Faso Ghana Mali Niger Senegal	• Expand the scaling up of equitable climate services • Support the development of country action, plans for CSA • Conduct pilot tests on CSV models with the networks of farmers and agricultural producers, organizations of West-Africa
Latin America	Colombia El Salvador Guatemala Honduras Nicaragua Peru	• Gathering evidence from CSVs • Focusing on agro-climate and extension services as key components
South-East Asia	Cambodia Laos Vietnam	• Participatory approaches in organizing the CSVs • Evaluating CSA innovations from other partner
South-Asia	Bangladesh India Nepal	• Developing the evident base for CSVs • Improved crop insurance products • Developing decision support tools for national and sub-national adaptation plans

In addition to this, the Consultative Group on International Agricultural Research (CGIAR) approved research program on Climate Change, Agriculture and Food Security (CCAFS) in 2011 which is

one of the biggest CGIAR research programme, this addresses the challenges of climate change, weather variability and hence global warming which poses an adverse effect on food security and agricultural producers, production systems and policies and institutions (Neufeldt et al., 2013; Nelson et al., 2010). CCAFS works across five regional Programme i.e., East Africa, West Africa, Latin America. South Asia and South-East Asia. It has been organized in four projects:

- Climate Smart Agricultural Practices
- Climate Information Services and Climate Safety nets
- Low emissions agricultural developments
- Policies and institutional for climate resilient food systems

With this overview, FAO coined the term in preparation for the 2010 Hague Conference on Food Security, Agriculture and Climate Change, and CCAFS was an early partner in the development of CSA. The approach asserts that the addressing of emerging climate risks while reducing greenhouse gas emissions requires new technologies, policies, institutions and investment, and in addition to that, the context specific interventions are required (Nyasimi et al., 2014; Rioux et al., 2016).

CSA is a conceptual approach developed by a set of agencies to advocate for changes in the ways that agriculture is practiced and agricultural development is understood in regard of climate change impacts. It involves the optimization of the balance of three, sometimes conflicting objectives: sustainably increasing agricultural productivity to support equitable increases in farm incomes, and better food security; adapting and building resilience of agricultural and food security systems to climate change at multiple levels; and reducing greenhouse gas emissions from agriculture (including crops, livestock and fisheries) (Williams et al., 2015; Selvaraju et al., 2011). CCAFS also works at the global level by advancing the CSA concept through Global Alliance on Climate Smart Agriculture (GACSA), by strengthening the influence of regions in global spheres [for example capacity strengthening of the African Group of Negotiators (AGN) in the UNFCCC], and by contributing to the bodies of research reviewed and systematized by the IPCC (Prasad et al., 2014; Rioux et al., 2016; Schimidhuber and Tubiello, 2007).

The National Adaptation Fund for Climate Change (NAFCC) was established in August, 2015 to meet the cost of adaptation to climate change for the State and Union Territories of India that are particularly vulnerable to the adverse effects of climate change. The government has set up a budget provision of Rs. 350 crores for the year 2015-16 and 2016-17, with an estimated requirement of Rs. 181.5 crores for financial year 2017-18 for NAFCC. The projects under NAFCC prioritizes the needs that build climate resilience in the areas identified under the SAPCC (State Action Plan on Climate Change) and the relevant Missions under NAPCC (National Action Plan on Climate Change) (Mwongera et al., 2017; Lipper et al., 2014; Prasad et al., 2014).

The impact pathways were developed by CCAFS to involve working in concert with other programs that promote CSA, including the GACSA that is supported by some multi-lateral organizations,

donors, players from the private sector and other stakeholders. CCAFS sees its alignment with the GACSA as a way to act collaboratively and to promote "an overarching global framework for CSA investment". With this background, by transforming production systems into more climate resilient system which can lead to more food security, less poverty and less degradation of natural resources, a workshop was organized by Asia-Pacific Association of Agricultural Research Institutions (APAARI), CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS), World Meteorological Organization (WMO) and United Nations Development Program (UNDP) on Climate Smart Agriculture in Asia in which various objectives related to climate smart agriculture have been discussed i.e., the best practices and technologies being used to make agriculture smart, latest knowledge of impacts of climate change on agriculture and the various gaps that exist in the solutions available and prioritized research and development needed to fill these gaps have been part of the discussion. There are many pathways for adaptation of Asian agriculture to progressive climate change such as altered genotypes, cropping seasons and systems; better management of resources, insect-pests and diseases; breeding of stress resistant genotypes; infrastructure development; capacity building; and policy making. Most important for adaptation of Asian agriculture to progressive climate change is the strategy and technology development and dissemination for much better adaptation of agriculture to the current environment. There is a need for an efficient information system to monitor and predict climate change effects on agro-ecosystems, develop agricultural hazard maps, and provide early warning for biotic and abiotic stresses and decision support for adaptive management (Reid et al., 2009; Rioux et al., 2016).

As per the FAO estimate, by the year 2050, world population will increase by one-third and food required for food security by 60 per cent (Nelson et al., 2010). Agriculture has become a high-risk profession towards climate change and weather variability, which have direct impact on farmers' socio-economic condition. So, there is a need to study the different aspects and concepts of climate smart agriculture. So, climate smart agriculture is an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. CSA is an approach that encompasses agricultural practices, policies, institutions and financing to bring tangible benefits to the farmers. The core challenge is to sustainably improve food production and increase the resilience of farming systems and livelihoods. CSA is an integrative approach to address these interlinked challenges of food security and climate change with following objectives:

- Sustainably increasing agricultural productivity, to support equitable increases in farm incomes, food security and development.
- Adapting and building resilience of agricultural and food security systems to climate change at multiple levels.
- Reducing greenhouse gas emission from agriculture (including crops. Livestock and fisheries).

It is an approach for addressing the development efforts towards the technical, policy and investment condition related issues to achieve sustainable agricultural development for food security under climate change along with the eradication of poverty. CSA contributes to a range of national food security and development goals and requires coordination across all the agricultural sectors and other related sectors, such as energy and water. CSA covers multiple levels and provides synergies between adaptation, mitigation and food security goals. So, to make agriculture a sustainable livelihood, intensive efforts at ground level will be required to make agriculture climate smart. There is a need to understand several reasons which make development and dissemination of CSA technologies and practices more challenging. CSA is not a simple ensemble of actions, rather it must be understood in connection with multidisciplinary vision. There must be adequate capacity at different levels to perform the actions and changes needed and political will to support the implementation of climate smart actions. This implies engaging multi actors' interests and promoting their active involvement. Broadly, all stakeholders from top level to bottom level should act as one to address the increasingly negative impact of climate change and weather variability by securing adequate policies, technical and financial conditions for increased productivity, building resilience and the capacity to adapt and seeking opportunities to mitigate emissions of greenhouse gases. Investments in water management and irrigation infrastructure, seed systems, and extension services are key for addressing crop yield gaps, especially in a context where weather is expected to become more variable and unpredictable, with increased and more intense climate shocks. To ensure adequate targeting of adaptation and mitigation investments at local levels, more efforts should be made to develop and deploy integrated decision support systems that compile and analyze the weather, agronomic, and market information, and deliver timely results to a range of stakeholders and decision makers (Mwongera et al., 2017; Lipper et al., 2014; Prasad et al., 2014).

As climate changes, so does the role of agricultural advisory and extension services. Demand for new climate services is increasing. Farmers need wide-ranging advice on how to adapt their farming practices and their entire livelihoods, to take advantage of viable, profitable options with manageable levels of risk. The CSA requires changes in farming households' behavior and strategies, as well as changes in the usual timing of agricultural practices. Without appropriate institutional structures in place, the innovations required to implement CSA may seem overwhelming to farmers. Successfully managing change demands accurate and up-to-date information, a degree of financial capacity and, if the changes are to be far-reaching, the ability to cooperate with others on a broad scale. Putting CSA into practice successfully, the stakeholders involved have different roles and should have efficient collaboration among themselves to make farming climate smart (Bayala et al., 2016; Branca et al., 2012; Dinesh et al., 2015).

Climate Smart Agriculture: An Approach to Adaptation and Mitigation

In response to these high susceptibilities to climate change and weather variability, it is important to study various adaptations of climate smart agricultural practices to mitigate weather risks

in agricultural production. The costs of adapting agriculture to climate change can be large and methods are not always well known. Mitigation efforts will require information through education and technology transfer. Agricultural Extension and Advisory Services, thus have a major role to play in providing farmers with information regarding various latest smart technologies and practices to cope with the climate adversaries and offer an opportunity to support CSA objectives, in particular in four areas:

- **Technology development and information dissemination:** RAS is at an advantage of having a wealth of approaches for developing technologies and disseminating knowledge. The challenge is to continuously identify and adapt solutions to adjust to the changing climate. This will require collaboration at multiple scales beyond the farmer/household level.
- **Strengthening farmers' human and social capacity:** This includes observational and experimental skills, critical thinking and problem-solving abilities. This requires extension agents to move away from delivering technology "packages" and blanket recommendations; integrate skills from specialized areas, such as marketing, as well as soft skills at the individual and organizational level.
- **Facilitation and brokering:** This includes linking farmers to research, traders, input suppliers, meteorological services, insurance companies, etc. To effectively perform this function, RAS needs to strengthen their capacity in network building, brokerage, process facilitation/monitoring.
- **Advocacy and policy support:** RAS could play an important role in advocacy for climate change action and allocation for CSA in decentralized government structures and in explaining climate change policies to rural communities. Ensuring that agriculture becomes climate smart is a priority for addressing the need for adequate, nutritionally balanced food for a growing and more demanding population in a situation of resource limitations, and climate change and variability. Uptake of climate smart technologies, tools and practices is still largely an ongoing and challenging process. Barriers at different levels must be overcome in all countries and solutions to these challenges must respond to specific local needs. The adoption of climate related knowledge, technologies and practices to local conditions, promoting joint learning by farmers, researchers, rural advisor and widely disseminating CSA practices is critical. The climate smart agriculture (CSA) concept reflects an ambition to improve the integration of agriculture development and climate responsiveness. It aims to achieve food security and broader development goals under a changing climate and increasing food demand. CSA initiatives increase productivity and sustainability, enhance resilience, and reduce/remove greenhouse gases (GHGs), and require planning to address tradeoffs and synergies between these three pillars: productivity, adaptation, and mitigation. The priorities of different countries and stakeholders are reflected to achieve more efficient, effective, and equitable food systems that address challenges in environmental, social, and economic dimensions across productive landscapes. While the concept is new, and still evolving, many of the practices that make up CSA already exist worldwide and are used by farmers to cope with various production risks. Mainstreaming CSA requires critical stocktaking of ongoing and promising practices for the future, and of institutional and financial enablers for CSA adoption.

The adaptation fund under UNFCCC (United Nations Framework Convention on Climate Change) was established in 2001 and officially launched in 2007 which aims to finance concrete projects and programmes that help vulnerable communities in developing countries. The fund aid financed in part by government and private donors and the World Bank serves as trustee of the adaptation fund on an interim basis. Six states, i.e., Andhra Pradesh, West Bengal, Madhya Pradesh, Tamil Nadu, Rajasthan and Uttarakhand have been covered under this adaptation fund scheme which acts as the pillar of climate smart agriculture (Butler et al., 2015; Chatrchyan et al., 2017)

India's National Action Plan on Climate Change

Climate change is a global challenge with diverse implications at the national and subnational levels through impacts on various sectors such as agriculture, water resources, forestry and biodiversity, human health, energy and infrastructure. Such diverse impacts require a range of strategies to be deployed for an effective response and for better preparedness towards climate change. One more effort to make agriculture smart, green climate fund was set up by UNFCCC in 2010 through which NABARD financed resources from green climate fund for India to mitigate adverse impacts of climate change and weather variability. To implement climate smart agriculture practically, in 2008, a National Action Plan on Climate Change (NAPCC) for India was released in view of addressing the challenges posed by climate change along with the imperatives of poverty alleviation and economic growth for India. The focus of NAPCC is to improve the understanding of climate science, adaptation, mitigation, energy efficiency and natural resource management and conservation. There is a need to achieve synergy between national priorities and state-specific strategies, given that in many cases the actions being discussed are state subjects and have to be implemented in the states. While adaptation by its very nature is localized in action, mitigation actions taken at the state level can tap on the opportunities that the state can benefit from or follow a co-benefits approach simultaneously buttressing national mitigation efforts. In this context, it becomes crucial to prepare state level action plans on climate change in order to address current and future climate risks and tap on potential opportunities through a diverse set of response strategies. The first step towards preparation of a detailed State Action Plan on Climate Change (SAPCC) is to identify state-specific risks and impacts and opportunities in the context of climate change. Thereafter, prioritize areas for research and policy action in response to identified current and future vulnerabilities and projected impacts of climate change. Effective policy design could be laid by identiying strategies with national priorities and missions.

After the introduction of the concept of Climate Smart Agriculture, various initiatives have been started i.e., The National Adaptation Fund for Climate Change (NAFCC) was established to meet the cost of adaptation to climate change for the State and Union Territories of India that are particularly vulnerable to the adverse effects of climate change. The projects under NAFCC prioritize the needs that build climate resilience in the areas identified under the SAPCC (State Action Plan on Climate Change) and the relevant missions under NAPCC (National Action Plan on Climate Change). Various states have been undertaken for the projects and programmes related

to climate smart agriculture. Under the National Adaptation Fund for Climate Change (NAFCC), various projects have been sanctioned in different states i.e., Punjab, Himachal Pradesh, Odisha, Manipur, Tamil Nadu, Kerala, Mizoram, Chhattisgarh, J&K, Meghalaya, Telangana, Andhra Pradesh etc. In order to keep up with the challenges of ensuring food security for growing populations, the need for specific and reliable data for adapting and mitigating risks to agriculture from climate change and weather variability and to include farmers as stakeholders in the data revolution, the Department of Biotechnology (DBT), India recently launched "Farmer Zone" which is targeted at improving the lives of farmers by catering to a variety of farming needs from coping with climate change, weather predictions and soil water and seed requirements, market linkages to sell produce directly from the farm. The main aim of this platform is to design a model that can be scaled up and applied across a number of different agro-climate zones. At the 22nd Conference of Parties in Marrakech (COP22) called as "Action COP" and "Agriculture COP" major initiatives in agriculture sector like Global Alliance for Climate Smart Agriculture (GACSA) and Adaptation of African Agriculture (AAA) have been proposed and discussed. Both of these initiatives are being promoted by the Food and Agriculture Organisation of the United Nations (FAO) along with various governments, NGOs, farmers producers, etc.

Stakeholder analysis in Climate Smart agriculture

Stakeholder analysis is a process of systematically gathering and analyzing qualitative information to determine their interests, priorities, knowledge, position, and potential alliance with other stakeholders. The FAO success stories in various countries are a constant reminder that the magnitude, immediacy and broad scope of the effects of climate change is such that there is a compelling need to ensure their comprehensive integration into national as well as provincial agricultural planning, investments and programs. Successful transition to the CSA will require changes in behavior, strategies and agricultural practices of farming households, including improved access to climate-resilient technologies, climate and market information, and associative capacities for collective action. These changes should be supported by extension providers. However, in many countries the engagement of extension providers in CSA-specific efforts is currently low, especially that of public extension/rural advisory services (RAS). So by means of stakeholder analysis one can know about all the happenings and activities done by the stakeholders which may be extended organizations, public sectors, private sectors, non-governmental organizations etc (Schmeer 1999; Madukwe and Obiora 2012; Carter 2009; Butler et al., 2015).

CSA practices are tailored to the specific characteristics of local farming systems, the particular socio-economic conditions, agro-ecological context and farmers' requirements. For sustainable and long-term adoption of CSA practices, farmers receive immediate and long-term benefits from these practices in terms of improved food security, food production and income. Because the adoption of CSA practices is largely determined by training sessions and farmer-to-farmer learning, it is important to support sustainable approaches for delivering extension services. For designing

effective CSA programmes, extension strategies and investment plans, it is essential to gain a better understanding of both the gender-sensitive incentives (e.g. secure land tenure and the availability of credit, farm tools and inputs) and the barriers to the adoption of CSA practices which can be demonstrated for scaling up.

Institutions can affect the roles of governing access to and control over resources and assets for adaptation, thereby influencing the distribution of climate risks and impacts across different social groups. Social and cultural norms and the rules governing behavior influences the extent to which individuals and groups within a community are able to participate in and benefit from collective action. For CSA implementation, it is important to identify an integrated package of climate-resilient technologies and practices for the management of crops, livestock and aquaculture at the farm level, while considering the linkages between agricultural production and ecosystem services at the landscape level. Testing and applying different practices are important to expand the evidence base, determine which practices and extension methods are suitable in each context and identify the synergies and trade-offs between food security, adaptation and mitigation.

Innovative information and improved communication are vital requirements for sustainable agriculture development in present scenario, hence cyber technologies like mobile, internet based agro-advisory services, and success stories based movies must be used in information communication system to mitigate the farmers' problems. Various approaches of agricultural extension and rural advisory services provide information from research to end users as new extensionist had now mutated from a production centered to an integrated cross-sectional function of the extension ecosystem in achieving climate smart agriculture. Particularly the voice of farmers must be actively taken into account as they are the key actors to promote sustainable agriculture and their issues need to be prioritized. The advantages linked to the adoption of climate smart management tools, approaches should be clearly identified and shared which are the indicators of climate smartness of farmers. Climate smart agriculture had a wealth of experience in disseminating technologies, information, practices with a range of approaches including traditional extension modes (e.g. interpersonal interaction, demonstration, field days, printed materials etc.), ICTs (radio, mobile phones, video, social media, rural resource centers), farmer to farmer extension and farmer field school etc. The importance of agricultural research and extension cannot be overemphasized, especially with the increasing recognition of value added technical services for the direct benefit of farmers and farming systems. There were a wide range of benefits associated with stakeholder engagement which include learning and awareness raising, enhancing legitimacy, building stakeholder networks and ultimately strengthening decision making around climate change adaptation. To make the transition to CSA, strong institutional support is required to improve the dissemination of information, provide financial support and access to markets, and coordinate the work of a large number of farmers over a wide area. The needs, priorities and drivers of individual institutions must be understood and managed suitably to successfully establish the needed CSA collaborations. Institutional synergies and networks for knowledge exchange are key to establishing, maintaining and scaling up CSA initiatives.

All the institutions and stakeholders involved in CSA supported in three vital areas i.e.,

- Producing and sharing technical knowledge
- Producing financial services, credit and access to markets
- Supporting the coordination of collaborative action

Different players in the agricultural sector need completely different types of climate advice and this has to be planned and evaluated by analysis of all the aspects related to CSA known and done by these players. They should mediate between different possibilities and market actors because improved extension services should not provide 'one-size-fits-all' solutions or static advice. Civil society has considerable potential to exercise influence by using its collective political voice to express local climate concerns to higher authorities and demand the provision of specific measures or services. It is crucial to understand the interrelationships between civil society organizations, the government and the private sector. As markets become increasingly important in developing economies, private sector actors will also become significant providers of research and development, education and extension services. When seeking private sector support for CSA initiatives, it is important to bear in mind the private sector's main priorities. CSA works to establish a 'triple win' scenario in which innovative practices produce higher yields, build resilience to climate change (reducing long-term risks) and lower carbon emissions all along the supply chain. By contributing to CSA, private businesses can enhance their brand recognition among key suppliers and consumers. The local stakeholders (e.g. farmers and employees of local agriculture-related organizations) may be formal, such as cooperatives and farmer's unions and organizations or informal. Partnerships between farmers' unions and decentralized training institutes need to be strengthened to empower national farmers' federations to act as direct, CSA-specific service providers to farmers.

The importance of partnership in any developmental programmes is widely accepted by those who have been working on these programmes. However, the issue of how to build strong links and partnership is often neglected. So, actor linkage approaches emphasises on identifying the key actors involved in a system/programme, mapping the links and information flow among them and looking at how these inhibit or support proper innovations. These actors/stakeholders oriented tools describe the linkages, collaborations and relationships between the different stakeholders involved in a particular programme/project.

With this background, policymakers and other organizations can use stakeholder analysis to identify key stakeholders and to access their knowledge, interests, positions, alliances and importance related to climate smart agriculture.

Adoption Barriers and Incentives of Climate Smart Agriculture

Climate change adaptation and mitigation are considered as the important objectives of climate smart agriculture where majority of the population depends on farming. For successful implication

of climate smart agriculture, there is a need to examine the incentives and constraints faced by stakeholders/actors while adopting these CSA practices. So, understanding the determinants of a stakeholders' decision to adopt a particular practice among the available choices may provide insights into the factors that enable or constrain adaptation. This examination provides useful knowledge on the dynamics of adoption of the CSA practices. Adoption of these CSA practices can be affected by policies, institutional and social structures and processes which may affect adoption. It was found in one of the study conducted in Nepal that most of the local governments and communities in developing countries have limited knowledge and capacity to adapt to the impacts of climate change. Because the adoption of CSA practices is largely determined by training sessions and farmer to farmer learning, it is important to support sustainable approaches for delivering extension services (Long et al., 2016; Mutoko et al., 2015).

In one of the study conducted by FAO, confirmed that connecting research, practice and policy is critical for effective scaling up of CSA. It is important that new climate finance instruments be integrated with the traditional sources of agricultural investment in ways that can underpin the design and implementation of national action plans related to CSA. In another study, a range of factors influence the adaptation of climate smart agriculture practices i.e., farm size, farm income, use of credit and subsidies. It was also found that wider policy, institutional and social structures and processes may affect adoption (Long et al., 2016; Mutoko et al., 2015).

The main constraints to adopt of CSA practices include unpredictability of weather, high farm input cost, lack of access to timely weather information and water resources. A clear understanding of the factors that influence farmers' adaptation decisions is essential to the designing of appropriate policies to promote effective adaptation in the agricultural sector. Adopting multiple CSA techniques helps in building a sustainable agricultural production system, well resilient to climate related shocks. All the relevant stakeholders should strive to provide farmers with climate smart agriculture related extension messages. Stakeholders' ability to adapt to climate change and weather variability is determined by many predictor variables which are social, cultural, economic and institutional in nature. Factors that influenced the selection of CSA practices include stakeholders' region, knowhow and availability of resources. According to the experts, government and local councils should be fully involved from the onset for effective impacts and long-term support. Farmers and expert participatory workshops and field visits allows people with different background, skills and experiences to bring innovative ideas on CSA that can be upscaled to different areas. The adoption of these mitigation and adaptation measures, practices and technologies (hereafter defined as "climate smart") lags behind the research, even though farmers must be taking action now so as to limit the impacts of climate change. Identifying the reasons behind the limited adoption of climate-friendly practices is essential to understand and address this gap. This activity is an important precursor to designing or restructuring policies to stimulate climate smart behavior(Long et al., 2016; Mutoko et al., 2015).

This study aims to provide an analytical description of "who is doing what" in the field of climate

smart agriculture and to identify the critical gaps and challenges for implementing and using climate smart agriculture practices and policies through national and local government and non-government actors. The study reviews the existing policy and institutional framework, funding mechanisms, and major institutional actors working in the field of climate change and climate smart agriculture practices' adaptation to provide a better understanding of their current priorities as well as the critical areas that are not being addressed. Continuous involvement of the county administration, local leaders, NGOs, civil societies are necessary to foster local enrollment and support CSA implementation. Policies are prepared on the basis of existing technologies and knowledge from top to middle level while vacuum at the bottom still remains unaddressed. Only a chosen few are benefited while the majority are left out of the development process. Gaps exist in the same villages/taluks/blocks/ with the same resources. There is a need to analyze the roles and actions of all the stakeholders involved in climate smart agriculture related programmes. So, to answer these questions a research problem entitled "Climate smart agriculture towards triple win in agriculture production" is proposed with the following objectives:

1. A comprehensive assay of stakeholders involved in climate smart agriculture.
2. Determinants for the adoption of climate smart agriculture.

Research Methodology

After thoroughly studying the available literature, the suitable research methods and appropriate tools were selected to conduct this study. The purpose of this chapter is to describe the research methods and techniques used in conducting this research.

Description of the Locale of the Study

The study was conducted in Himachal Pradesh State of India. Himachal Pradesh a hilly state in North India in the western part of the Himalayan range, it has a geographical area of 55,673 km2. The state is predominately agricultural where the sector provides direct employment to about 71 percent of the total population. The economy of the state is dependent on sectors like the horticulture, agriculture, forestry, tourism, etc., and these sectors are assumed to be under threat in the present scenario of changing climate. Any change in these sectors due to climate change, in every likelihood, will not only affect the livelihood prospects in the agrarian economies of mountain regions, but also everyone living below in the plains. In the context of current climate trends in Himachal Pradesh, both precipitation (rainfall and snowfall) and temperature are considered to be the significant indicators. The state faces a number of climatic stressors and weather variations, i.e., change in maximum and minimum temperature, erratic rainfall, fluctuating relative humidity, etc., which has an adverse impact on agricultural and horticultural production. The agriculture-horticulture sector of the state is highly dependent on weather and climate. Seasonal weather variability in conjunction with climate change has long term effects on agricultural production, agribusiness investments and regional prosperity. The state being a part of Himalaya is highly vulnerable since 35 percent of the total geographical area of the state falls in very high damage risk zone as Zone V and remaining in Zone IV. Nearly 63 percent of workers in the State are engaged in agriculture or horticulture for their day to day requirements. The livelihood strategies being followed by the people of the state are highly vulnerable to the suffering resulting from erratic behavior of the weather. The average size of land holdings is small with many fields being on steep land that do not permit mechanization of farming activity. High cost of creating and maintaining physical infrastructure for farming activity also act as constraints resulting in low resilience from weather vagaries.

Area of Study: The districts, Bilaspur and Hamirpur have been selected randomly from top five vulnerable districts on the basis of a report given by the State Action Plan on Climate Change. According to this report the above selected districts were found to highly vulnerable towards climate change and weather variability. These districts were also found to have high exposure and sensitivity and lowest adaptive capacity which made them highly vulnerable towards climate change and weather variability. From the review of literature, it was found that NICRA project and State Action Plan on Climate Change were carried out in these districts.

Selection of the Respondents: Different stakeholders will form the sample size of the present study. Dimensions of involvement of different actors and stakeholders will be determined by

Stakeholder Analysis. Under National Initiative for Climate Resilient Agriculture project, KVK is the nodal agency which is working for climate change and climate smart agriculture. So, it was selected as major stakeholder for the study and then by using a snow ball sampling method, other stakeholders were selected. KVK Bilaspur and KVK Hamirpur were selected as the primary stakeholders to collect data and these were the link to other secondary stakeholders. Some other projects working on climate change were identified with the help of these stakeholders.

Research Design: For the purpose of this study both qualitative and quantitative data were collected in the geographical area of the target population. A semi-structured interview schedule was prepared to do the stakeholder mapping and analysis. The data were collected regarding priorities, interests, knowledge, positions, coordination and collaboration of the stakeholders involved in climate smart agriculture. Focus group discussions and observation methods have been used to collect the information regarding various adoption barriers and incentives for climate smart agriculture.

Construction of Research Instrument: An interview schedule was considered as an appropriate tool for gathering information from the selected stakeholders involved in climate smart agriculture. It consists of three phases:

- **Phase I:** Climate smart agriculture related projects included different actors from top level to the bottom level. This part included the procedures and methods of mapping of stakeholders. Information was collected after reviewing the annual reports, research papers, websites of different institutes involved in climate smart agriculture.
- **Phase II (a):** After identifying the stakeholders, they were interviewed in groups or individually of the selected study areas with the help of semi-structured schedule which includes stakeholders' type of activities, transparency, sources of the fund, collaboration among different stakeholders, participation of various stakeholders, policy framework etc., towards climate smart agriculture. Key informants and focus group discussions were also used to get valuable information.
- **Phase II (b):** Information about various barriers faced by different stakeholders while adopting climate smart agricultural practices and also various incentives which increased their use of these practices were collected. It also consisted the statements related to various problems and conflicts faced by stakeholders, i.e., Government, non-government, civil society, research institutes, media etc., regarding climate smart agriculture.

Data Collection Tools and Techniques

The study used both primary and secondary data. Secondary data was used to explore various climate smart agriculture related projects in the selected districts of Himachal Pradesh which provided background of basic information to achieve objectives of the study. The primary data was collected by conducting face to face interviews to all the stakeholders involved in climate smart agriculture related projects. Focus group discussions and observation method were also carried out for the data collected.

Results and Discussions

This section deals with the results of the study, which emerged after the compilation, analysis and interpretation of the data. For better comprehension of the results, they have been presented under different sections. Each section gives a detailed account of the results of the study and presents an analytical view of the same by discussing their various dimensions. Keeping in view the objectives of the study, a stakeholder analysis was conducted in the selected districts of Himachal Pradesh to know all the stakeholders and their working networks, activities, performances, adoption barriers and incentives etc. regarding the climate smart agriculture and its related practices conducted in that particular area. The results and discussion have been presented under the following heads:

1. Identification of the programmes and the stakeholders involved in climate smart agriculture

Identification of the programmes and the stakeholders involved in climate smart agriculture and its related activities in the districts of Bilaspur and Hamirpur of Himachal Pradesh. Both national and state sponsored programmes exist which are running out in these districts (Bilaspur and Hamirpur) with domain of climate change and its adaptation and mitigation:

a) Sustainable Livelihoods

i) National Innovations in Climate Resilient Agriculture (NICRA): National initiative on Climate Resilient Agriculture was launched during February 2011 by the Indian Council of Agricultural Research (ICAR) with the funding from the Ministry of Agriculture and Farmers' Welfare, Government of India.

Objectives

With this background, the ICAR has launched a major Project entitled, National Initiative on Climate Resilient Agriculture (NICRA) during 2010-11 with an outlay of Rs.350 crores for the XI Plan with the following objectives:

- To enhance the resilience of Indian agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies
- To demonstrate site specific technology packages on farmers' fields for adapting current climate risks
- To enhance the capacity building of scientists and other stakeholders in climate resilient agricultural research and its application.

Project Components

Both short term and long term outputs are expected from the project in terms of new and improved varieties of crops, livestock breeds, management practices that help in adaptation and mitigation and inputs for policy making to mainstream climate resilient agriculture in the developmental planning. The overall expected outcome is enhanced resilience of agricultural production to climate variability in vulnerable regions. The project is comprised of four components:

- Strategic research on adaptation and mitigation
- Technology demonstration on farmers' fields to cope with current climate variability
- Sponsored and competitive research grants to fill critical research gaps
- Capacity building of different stakeholders

ii) National Mission on Sustainable Agriculture (NMSA)

Sustaining agricultural productivity depends on the quality and availability of natural resources like soil and water. Agricultural growth can be sustained by promoting conservation and sustainable use of these scarce natural resources through appropriate location specific measures. Indian agriculture remains predominantly rain fed covering about 60% of the country's net sown area and accounts for 40% of the total food production. Thus, conservation of natural resources in conjunction with the development of rainfed agriculture holds the key to meet burgeoning demands for food grain in the country. Towards this end, National Mission for Sustainable Agriculture (NMSA) has been formulated for enhancing agricultural productivity, especially in rainfed areas focusing on integrated farming, water use efficiency, soil health management and synergizing resource conservation. NMSA caters to key dimensions of 'water use efficiency, 'nutrient management' and 'livelihood diversification' through adoption of sustainable development pathway by progressively shifting to environmental friendly technologies, adoption of energy efficient equipments, conservation of natural resources, integrated farming, etc. Besides, NMSA aims at promoting location specific improved agronomic practices through soil health management, enhanced water use efficiency, judicious use of chemicals, crop diversification, progressive adoption of crop-livestock farming systems and integrated approaches like crop-sericulture, agro-forestry, fish farming, etc. NMSA has the following objectives; 1. To make agriculture more productive, sustainable, remunerative and climate resilient by promoting location specific Integrated/Composite Farming Systems; 2. To conserve natural resources through appropriate soil and moisture conservation measures; 3. To adopt comprehensive soil health management practices based on soil fertility maps, soil test based application of macro & micro nutrients, judicious use of fertilizers etc.; 4. To optimize utilization of water resources through efficient water management to expand coverage for achieving 'more crop per drop'; 5. To develop capacity of farmers & stakeholders, in conjunction with other on-going missions e.g. National Mission on Agriculture Extension & Technology, National Food Security Mission, National Initiative for Climate Resilient Agriculture (NICRA) etc., in the domain of climate change adaptation and mitigation measures; 6. To pilot models

in select blocks for improving productivity of rainfed farming by mainstreaming rainfed technologies through NICRA and by leveraging resources from other schemes/missions like Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Integrated Watershed Management Programme (IWMP), RKVY etc.; 7. To establish an effective inter and intra Departmental/Ministerial co-ordination for accomplishing key deliverables of National Mission for Sustainable Agriculture under the aegis of NAPCC.

NMSA has the following three major programme components or activities:

Rain fed Area Development (RAD): RAD will adopt an area based approach for development and conservation of natural resources along with farming systems. This component has been formulated in a 'watershed plus framework', i.e., to explore the potential utilization of natural resources base/assets available/created through watershed development and soil conservation activities /interventions under MGNREGS, NWDPRA, RVP&FPR, RKVY, IWMP etc. This component will introduce appropriate farming systems by integrating multiple components of agriculture, such as crops, horticulture, livestock, fishery, forestry with agro based income generating activities and value addition. Besides, soil test/soil health card based nutrient management practices, farmland development, resource conservation and crop selection conducive to the local agro climatic condition will also be promoted under this component. A cluster based approach of 100 hectare or more (contiguous or non contiguous in difficult terrain with close proximity in a village/adjoining villages) may be adopted to derive noticeable impact of convergence and encourage local participation and for future replication of the model in larger areas. Supplementary support from this component will be admissible for gap-filling resource conservation activities under converging programmes. RAD clusters should have soil analysis/soil health card/soil survey maps to justify the interventions proposed and at least 25% of the farming system area will have to be covered under farm water management. Farming Systems recommended by ICAR's contingency plans and successful findings of NICRA projects shall also be considered in the development of an integrated project plan. Besides, creation and development of common property resources/assets/utilities like grain bank, biomass shredders, fodder bank, group marketing etc., will be encouraged under this component. Government of India has allocated funds to the tune of Rs. 12.92 crores during 2015-16 under this component.
Soil Health Management (SHM): SHM aims at promoting location as well as crop specific sustainable, soil health management, including residuemanagement, organic farming practices by way of creating and linking soil fertility maps with macro-micro nutrient management, appropriate land use based on land capability, judicious application of fertilizers and minimizing the soil erosion/degradation. Assistance will be provided for various improved package of practices based on land use and soil characteristics, generated through geographical information system (GIS) based thematic maps and database on land and soil characteristics through extensive field level scientific surveys. Besides, this component will also provide support to reclamation of problem soils (acid/alkaline/saline). This component will be implemented by State Govt., National Centre of Organic Farming (NCOF), Central Fertilizer Quality Control &

Training Institute (CFQC&TI) and Soil and Land Use Survey of India (SLUSI). Given the limitations, such as staff and infrastructure, faced by the department of agriculture at the field level, a public private partnership model may be adopted by states depending upon the private partner's strength in the field to ensure that the soil testing is done in time and in the numbers required. The private parties can be encouraged to set up soil testing labs in selected areas in the district. The Govt. of India has launched a new scheme based on which the sample of soil shall be drawn on GPS basis and total 69,635 samples would be analyzed this year. The GOI conveyed the approval of Rs. 241.62 lakh under NMSA for Soil Health Management component on 50:50 pattern.

Paramparagat Krishi Vikas Yojna: The state is bestowed with the potential of organic farming due to its huge natural resource, biodiversity, varied and rain fed agro climatic conditions. To promote organic farming, the Government of India has recently launched a new scheme, Paramparagat Krishi Vikas Yojna under the National Mission on Sustainable Agriculture for adoption of organic villages and PGS certification by mobilising farmers in cluster mode to enable them to certify their own organic products. Under the scheme, participatory guarantee system of certification will be followed in place of costly third-party certification system. Govt. of India has approved Rs.768.52 lakh on 50:50 basis for 2015-16. The project is for three years. Total 110 clusters of 50 acre (20 ha.) each will be selected and farmers will be trained in organic farming and the PGS system of certification.

b) Watershed Development

Pardhanmantri Krishi Sinchai Yojana (PMKSY): In an attempt to improve the Agricultural productivity, the Government of India has started a new scheme, the Pradhan Mantri Krishi Sinchai Yojana (PMKSY). Micro-irrigation projects ("Har Khet Ko Pani") and end-to-end irrigation solutions will be the key focus of this scheme. The major objective of the PMKSY is to achieve convergence of investments in irrigation at the field level, expand the cultivable area under assured irrigation, improve on-farm water use efficiency to reduce wastage of water, enhance adoption of precision-irrigation and other water-saving technologies. Water conservation and cutting down on wastage is key to bringing irrigation facilities to every farm in the country. This makes introduction of sustainable water preservation practices and optimization of water resources (More Crop Per Drop) just as important as the introduction of new irrigation facilities.

c) National Crop Insurance Scheme/ Pardhan Mantri Fasal Bima Yojna (PMFBY)

The state governament. has introduced this scheme from Rabi, 1999-2000 season. Crops covered are wheat, barley, maize, paddy, potato and ginger. Fifty percent subsidy on premium is being provided to small and marginal farmers. The scheme is compulsory for loanee farmers and optional for non-loanee farmers. The scheme provides comprehensive risk insurance against yield losses viz. drought, hailstorm, floods and pests disease etc. The Agriculture Insurance Co. of India (AICI) is

implementing the scheme. The farmers of the state can get benefitted out of this programme. The state govt and the government of India share the losses equally. From rabi 2007-08, the subsidy on premium has been raised from 10% to 50% to small and marginal farmers.

d) Adaptative Agriculture

i) H.P. Crop Diversification Project (JICA ODA Loan Project)

Himachal Pradesh Crop Diversification Project is being supported by JICA through an ODA loan. The study on diversified agriculture for enhanced farm income in Himachal Pradesh was conducted by the Japan International Cooperative agency (JICA) w.e.f. February, 2007 to December, 2008. Draft report of the study was submitted by JICA in December, 2008 and a final report in March, 2009. The study was fully funded by JICA as grant under bilateral cooperation. The report contains Crop Diversification Action Plan for 10 years and Master Plan for 15 years. Based upon the crop diversification potential, the state has been divided into four categories. JICA Contact Mission visited the state from 23-25th June, 2009 and had detailed discussion with the state government. The Mission showed their willingness to consider JICA ODA Loan for crop diversification project. The state was willing to cover entire state under the project and to provide JICA ODA Loan of Rs.949.00 crores as per the Master Plan projections but the JICA Mission expressed that rather than covering entire state from the outset (which requires extensive resources for implementation and longer time for project outcome), it would be more sensible to start the project by focusing on certain regions, crops, so as to get faster and tangible results. The result of the project can be replicated to other regions. It was also suggested to take maximum 4-5 districts with project cost of Rs. 250-300 crores. Based upon the JICA study and JICA Contact Mission report, Five districts comprising Kangra, Mandi,Hamirpur Bilaspur and Una which fall in category II & III i.e. the most potential areas for crop diversification were included in the project. The project proposal was submitted in May, 2009 to the Govt. of India for approval and financing. After a series of discussions, the projects' Minutes of Discussion (MoD) were signed between Govt. of India, JICA and Govt. of Himachal Pradesh on 01.10.2010 at New Delhi. The loan agreement was signed on the 17th February, 2011 between Ministry of Finance, Govt. of India and JICA and loan effectuation was done from 16th June, 2011. The annual plan 2015-2016, outlay of Rs. 60.00 crore has been made for execution of this project. The project area comprises 5 districts Kangra, Mandi, Hamirpur, Bilaspur and Una. The project period is 7 years i.e. 2011 to March, 2018 and the total project cost is Rs. 321 Crores (Loan Rs. 266 crores and Sstate share Rs. 55 crores). The launching of the project was done on 14th August 2011.

Objectives of the Project

1. To increase the area and production of vegetables through crop diversification.
2. To raise the income of small and marginal farmers.
3. To create infrastructures for irrigation, farm access roads, marketing, post-harvest etc.

4. To promote organic farming in a big way.
5. To organize farmers into groups to take over operation and maintenance of irrigation systems.
6. Training and capacity building of the Department of Agriculture's field extension staff.

The project is being implemented through the Himachal Pradesh Agriculture Development Society. It has Governing Council, Executive and Finance Committee. For overall management of the project, State Project Management Unit (PMU) has been set up at Hamirpur, three District PMU's at Palampur, Mandi, Hamirpur and 8Block PMU's at Dehra, Nurpur, Baijnath, Hamirpur, Una, Bilaspur,Mandi, Sarkaghat have been set up.

2. Stakeholder Analysis and Mapping under CSA Programmes

A. National Innovations in Climate Resilient Agriculture (NICRA)

National initiative on Climate Resilient Agriculture was launched during February 2011 by the Indian Council of Agricultural Research (ICAR) with the funding from the Ministry of Agriculture, Government of India. In Himachal Pradesh, this programme is going on in three districts viz., Hamirpur, Kullu and Kinnaur. In Hamirpur district, Krishi Vigyan Kendra, Bara is the nodal agency and has been running this project in two phases, i.e., Phase I (2011-2017) and Phase II (2018-2020) in six adopted villages of Panchay at Mann, District Hamirpur with the following stakeholders:

- Krishi Vigyan Kendra (KVK)
- Subject Matter Specialists (Nodal Officers)
- Indian Council of Agricultural Research (ICAR)
- Agriculture Technology and Research Institute (ATARI), Ludhiana
- Central Research Institute on Dry Land Agriculture (CRIDA, Hyderabad)
- State Agriculture University (CSKHPKV, Palampur)
- Input dealers
- H.P. Agro Industries (Pvt.) at Hamirpur and Palampur
- Vasudeva Pvt ltd. at Palampur
- Kisan Beej Bhandar
- Village Panchayat
- Village Climate Risk Management Committee (VCRMC)
- Farmers of the adopted villages
- Technical Staff
- Senior Research Fellows (SRFs)

Purpose of the Programme

- To enhance the resilience of the adopted villages' farmers by covering crops, livestock and fisheries to weather variability and climate change.
- To demonstrate site specific technology packages on farmers' fields for adapting tocurrent climate risks.

- To enhance the capacity of scientists and other stakeholders in climate resilient agricultural research and its application

Role and Collaboration of the Stakeholders

Table 2: Stakeholders involved in NICRA programme with their specific role

Sr. No.	Name of the stakeholder	Specific role
1.	Indian Council of Agricultural Research	• Development and launch of the programme • Funding Agency
2.	Krishi Vigyan Kendra	• Nodal agency to implement the programme • Problem analysis, identification of the issue of changing weather • Organizing extension activities like demonstratio
3.	ICAR- Central Research Institute for Dryland Agriculture (CRIDA, Hyderabad)	• Formulation of the activities and components with collaboration of ICAR • Allocation of Funds to ATARI • Management of the resources
4.	Agricultural Technology Application Research Institute (ATARI)	• Evaluation agency and allocating the funds to nodal agency i.e., KVK • Management of the fund flow mechanism and human resources
5.	State Agricultural University, CSKHPKV Palampur	• With the collaboration of KVK, the State Agriculture University, has been doing problem analysis, monitoring, assessment of impact
6.	Input dealers	• The input dealers with collaboration of nodal agency (KVK) provide the inputs like seeds, equipments (spray pumps, weeders to the beneficiaries
7.	Village Panchayat	• Inform the village community about the programe and gather them for any extension activity with the collaboration of village level committee
8.	Village Climate risk Management committee	• With collaboration of KVK officials, organize awareness camps, demonstrations and monitoring of the activities in the villages
9.	Farmers	• Actual beneficiaries of the programme

Activities taken under this programme

To accomplish the components of the NICRA project, KVK Bara, Hamirpur has been doing the following activities in the adopted villages:

Table 3: Demographic features of technology demonstration site under NICRA Programme

Sr. No.	Particulars	
1.	Adopted Villages	Tareti, Mann, Jangloo, Ghumarhata, Kuthera
2.	Panchayat	Mann
3.	Total Cultivated area	117.87 ha
4.	Major crops taken	Maize, wheat, vegetables cultivation for kitchen gardening
5.	Source of irrigation	Rainfed Farming

Activities:

Demonstrations: KVK Hamirpur, conducted different demonstrations on natural resource management, crop production, livestock and fisheries, fodder production in the adopted villages.

Table 4: Activities undertaken in all the adopted villages under Demonstrations of NICRA programme

Sl. No.	Particular	Interventions	Technology Demonstrated	Benefits
1.	Natural Resource Manage-ment	Mulching	Plastic mulching in cucurbits (Bitter gourd, bottle gourd and cucumber)	Increase in yield, reduced number of irrigations, reduced number of weeding and hoeing
		Tetra Vermbed	Vermi-compost preparation	Increase in yield by 20 per cent of the crops like vegetables, maize and wheat
2.	Crop production	Short duration (Zaid crop)	Toria	Increase in yield by 1.5 q/ha
		High yield variety	Maize resistance to lodging	Increase in yield by 2q/ha
		High yield variety	Wheat, early sown variety to exploit residual moisture	Increase in yield by 1.5q/ha and reduced in number of irrigations
		Drought tolerant	Brown sarson (KBS3)	Increase in yield by 1.5 q/ha and reduced number of irrigations
		Crop Diversification	Cabbage and cauliflower	Increase in yield by 30q/ha
		Moisture conservation through bio mass mulching	Elephant foot yam	Increase in yield by 150q/ha
		Pheromone e-trap for fruit fly	Management of fruit fly in cucumber	Increase in the yield 30 /ha

3.	Livestock and fisheries	• Artificial insemination • Breed upgradation • Deworming in livestock • Mineral mixture • Preventive vaccination
4.	Fodder production	• Azolla • Silage • Goatry feed

ii. Institutional interventions like climate literacy through a village level weather station, seed bank, community nursery, installation of small weather stations.

Table 5: Institutional interventions undertaken under NICRA programme

Sr. No.	Interventions
1.	Climate change literacy through a village level weather station
2.	Seed bank (HPW 349)
3.	Community Nursery • Cauliflower • Cabbage
4.	Post-harvest losses

iii. Capacity building of the farmers with regard to crop management, forestry system, natural resource management, commercial agriculture, fodder and feed management, soil health management.

Table 6: Capacity building component of NICRA programme in all the adopted villages

Sr. No.	Title of the Programme	Title of the trainings
1.	Crop Management	• Scientific management of maize, toria, kharifcrops, early sown wheat
2.	Plantation through Agro-Forestry Systems	• Development of uncultivated land
3.	Natural Resource Management	• Use of plastic mulch in vegetables
4.	Enterprises for self-employment	• Income generation activities for empowerment of rural women • Seven days on-campus vocational trainings on mushroom cultivation
5.	Fodder and Feed Management	• Refilling and remaking of silage unit. • Training on goatry feed suppliments.
6.	Soil Health Management	• Celebration of World Soil Health Day
7.	NICRA Awareness	• Parthenium education day • Integrated weed management • Pradhan Mantri Fasal Bima yojna • Celebration of World Food Day

8.	Pest and Disease Management	• Seed treatment in wheat • Insect pest and disease management in oilseeds • IPM of Rabi crops • Nematodes and their management in open and protected conditions
9.	Post-Harvest Management	• Minimization of nutrient losses in fruits and value added Aonla products • Value added products of papaya
10.	Vegetable Production	• Scientific cultivation of elephant foot yam, okra, cabbage, winter vegetables, cucurbits using ridge and furrow techniques and cauliflower

iv. Awareness camps have been organized in the villages by village climate resilient committee with collaboration of KVK officials.

v. Extension activities like field days, method demonstrations, group dynamics, kisan melas on Jai Jawan Jai Kisan Diwas for the farmers have been organised.

Table 7: Extension activities undertaken under NICRA programme in all the adopted villages

Sr. No.	Name of the activities	Remarks
1.	Field day on Maize and Toria	For scientific cultivation of maize and toria
2.	Method Demonstrations	Method demonstrations on silage making, azolla, okra cultivation, elephant foot yam cultivation, scientific management of maize cultivation, seed treatment, value added products, production of low cost pheromone traps have been taken place.
3.	Awareness	Awareness regarding technology related to agriculture, animal husbandry, resource management and crop insurance was provided.
4.	Group dynamics	For high income and profitability
5.	Kisan mela	Celebrate Jai jawan-jai kisan divas and provide awareness regarding crop diversification and crop management

Power and Interest of the stakeholders regarding Climate Smart Agriculture Programme NICRA

A project cycle starts from its planning, development, problem analysis, implementation, assessment of the results and ends up to its evaluation. In each of the steps of the project cycle, every stakeholder has their own power and interest. From the fig. 2, it is clearly revealed that the stakeholders viz., KVK, ICAR, ATARI and CRIDA of NICRA programme are positioned in a high power area which interprets that KVK has the power in problem analysis and implementation of the programme and ICAR and CRIDA develop and formulate the project activities according to the identified problems.

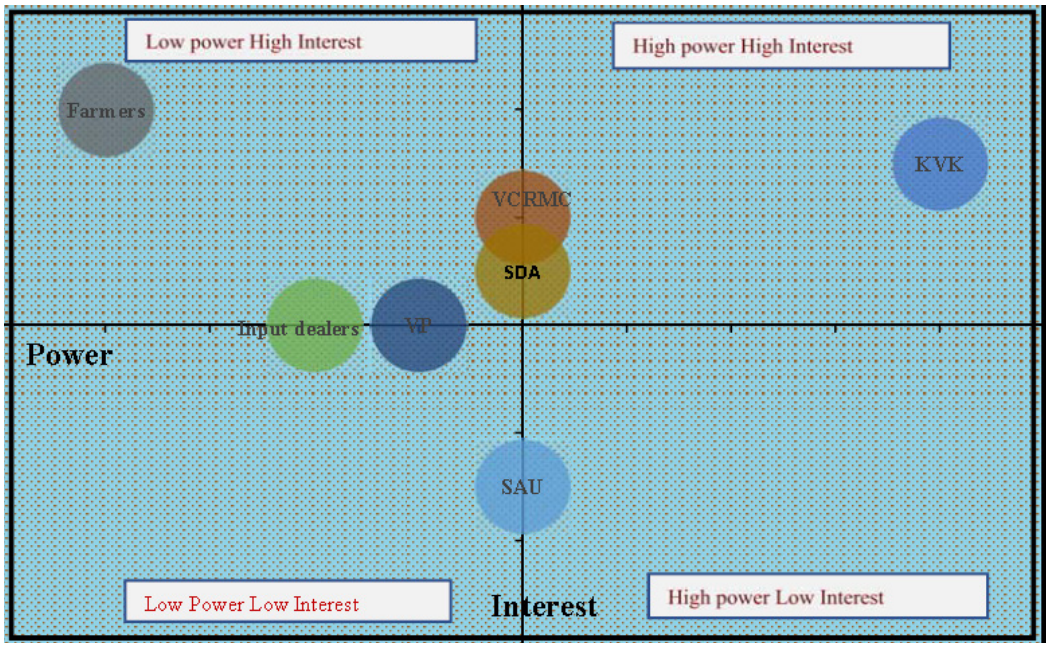

Fig 2: Power-interest grid of stakeholders involved in CSA (NICRA)

After implementation of the programme/project the ATARI, Ludhiana has the power to execute the funds to KVK and carried out the monitoring and evaluation of all the activities with the collaboration of State Agricultural University (CSKHPKV, Palampur) and State Department of Agriculture (SDA) in the adopted villages of district Hamirpur. On the other hand, at village level, farmers, village climate resilient management committee, input dealers, village panchayat have the interest in getting all the facilities, inputs, information from the programme to adapt the weather variability and solving the issues like sudden rise in temperature, erratic rainfall, high humidity, water scarcity, etc.

Relationship/Collaboration Analysis of Stakeholders (Actor Linkage Matrix)

The actor linkage matrix in the Table 3 clearly interprets that for NICRA programme, the implementing agency i.e., KVK has strong relationship with other stakeholders for doing problem identification and its analysis, solving the problems of weather variability and management of all the resources while the SDA and SAU has the strong relationship with KVK in monitoring and evaluation of all the activities done under NICRA programme.

Table 8: Actor-linkage matrix among the stakeholders involved in CSA (NICRA) programme in Hamirpur district

Stakeholders	KVK	ICAR	ATARI	CRIDA	SAU	SDA	Input dealers	Village Pancha-yat	VCRMC	Farmer
KVK	-	M	S	M	S	S	M	S	S	S
SAU	S	W	W	W	-	S	M	W	W	W
SDA	S	M	M	W	S	-	M	S	S	S
Input dealers	M	W	W	W	M	M	-	W	M	M

Village Panchayat	M	W	W	W	W	M	M	-	S	S
VCRMC	S	W	W	W	W	S	M	S	-	S
Farmers	S	W	W	W	M	M	M	S	S	-

Note: Strength of relationships is represented by Strong (S), Medium (M) and Weak (W)

On the other hand, farmers have strong relationship with Village Climate Resilient Committee (VCRC) and KVK in taking the benefits from this programme. It was also observed that the management authorities have weak collaboration with the farmers and Village Climate Resilient Committee who involved in the execution, planning, funding and evaluation of the activities with the collaboration of KVK, Hamirpur.

B. National Mission on Sustainable Agriculture (NMSA):

National Mission on Sustainable Agriculture (NMSA) has been formulated for enhancing agricultural productivity, especially in rainfed areas focusing on integrated farming, water use efficiency, soil health management and synergizing resource conservation. In districts Hamirpur and Bilaspur this programme has been under main three components viz., rainfed area development, soil health management and Paramparagat Krishi Vikas Yojna. Under this scheme various sub-projects have been covered, i.e., Rastriya Krishi Vikas Yojna (RKVY), Integrated Watershed Management Programme (IWMP). Following activities have been under this scheme:

- Awareness and training camps have been organized regarding integrating multiple components of agriculture, such as crops (maize, wheat, paddy, pulses), horticulture (vegetables, fruits), livestock (fodder management) to increase the component of an integrated farming system under this scheme
- Under soil health management component of this scheme soil testing laboratories provides the location as well as crop specific sustainable soil health cards to the beneficiaries on the basis of which farmers have been doing nutrient management practices, farmland development and resource conservation (soil, water, fertilizers)
- Under this scheme, common property resources also have been created like grain bank, biomass shredder for vermicomposting preparation and fodder bank for livestock feed management under scarce resources
- Under the Paramparagat Krishi Vikas Yojna component of the NMSA, trainings have been provided by KVKs, village level trainings by the state department of agriculture regarding certification of their own organic products in place of costly third-party certification system

C. Pardhan Mantri Krishi Sinchai Yojana

In the districts Hamirpur and Bilaspur under this scheme community based water harvesting structures and individual based water harvesting structures have been made for the purpose of controlling erosion and to irrigate the fields through minor dams, tanks, shallow borewell, etc. for

which farmers have been providing with the subsidies. Following activities have been done under this scheme:

- Provided the subsidies to the individuals on the basis of the capacity of the manufacturing tanks i.e.,

Sr. No.	Capacity of the Tanks	Maximum Subsidy (Rs.)
1.	$9m^3$	21000
2.	$20m^3$	36000
3.	$50m^3$	51000

- In case of shallow borewell scheme (up to 35m depth), beneficiaries have been provided with a subsidy of Rs. 110000/- per farmer
- Identified the villages by baseline survey where agricultural lands are there, but irrigation sources are not there
- Making out the village farmers association and discuss the work plan with them
- Under this scheme, farmers have been doing the construction work (making of dams, tanks, etc.) at their own under the supervision of nodal officers (soil conservation wing)with the provision of financial assistance to them
- Exposure visits have been done by soil conservation units at the construction points and monitoring and evaluation carried out with the collaboration of the village farmer association

D. Pardhan Mantri Fasal Bima Yojna (PMFBY):

Under Pardhan Mantri Fasal Bima Yojna, the Himachal Pradesh govt. have been implementing this scheme from Rabi, 1999-2000 season and in district Hamirpur and Bilaspur, the crops viz., wheat, maize, paddy and potato have been covered under this insurance scheme. A 50 per cent of premium have been provided to loanee and non loanee farmers. This premium is compulsory for loanee farmers and optional for non loanee farmers. Following activities have been done by stakeholders under this scheme in the district Hamirpur and Bilaspur:

- Awareness camps have been organized at village level to aware the farmers regarding the insurance scheme and the formalities involved in getting the premium
- Risks Covered: Insurance have been provided to cover yield losses due to non-preventable risks viz., Natural fire and lightening, storm, hail-storm, cyclone, typhoon, tempest etc., flood and landslides, droughts and dry spell and pest/diseases
- Seasonality discipline for loanee farmers:

Activity	Remarks
Loaning Period	Kharif: April to September Rabi: October to march
Cutoff date for receipt of declarations	Kharif: November Rabi: May
Cutoff date for receipt of yield data	Kharif: January/March Rabi: July/September

Table 9: Stakeholders with their specific roles and collaboration in these schemes

S. No.	Stakeholder	Role and collaboration
1.	State Department of Agriculture and Horticulture (SDA and SDH)	The Implementing agency of all the programmes/ schemes with the collaboration of all other line departments Monitoring and evaluation of the activities at village level
2.	Krishi Vigyan Kendra (KVK)	Organizing trainings, exposure visits and demonstrations of integrated farming systems, micro irrigation, organic farming, etc. with collaboration of state line departments regarding all the schemes
3.	Agriculture Insurance Companies (AICs)	Implementing agency of the scheme Pradhan Mantri Fasal Bima Yojana (PMFBY)
4.	Banks	Providing Kisan Credit Cards to the loanee farmers and 50 per cent premium to the registered farmers under PMFBY
5.	State Agricultural University (CSKHPKV, Palampur)	Organizing the trainings on various components of the scheme by Directorate of Extension. Evaluation of the activities done by implementing agency.
6.	Subject Matter Specialist (SMS)	Organized awareness and training camps with the collaboration of SDA and ADOs and AEOs
7.	Agriculture and Horticulture Development Officer (ADO & HDO)	Exposure visits, trainings, field days, demonstrations on organic farming, irrigation projects in collaboration with the village level extension officers
8.	Agriculture and Horticulture Extension Officer (AEO and HEO)	Village level problem analysis, awareness camps, and trainings with collaboration of ADOs and HDOs regarding these schemes
9.	Soil conservation wing	Implementing agency of PMKSY with the collaboration of SDA and making of the Krishi Vikas associations and to carry out the construction component under this scheme
10.	Soil Testing Laboratories	Soil testing on cluster basis and providing the soil health cards to the farmers
11.	Input dealers, Agriculture sale centers	Providing the inputs, i.e., seeds, equipments, tools etc., on subsidized rate which depends on the category of the farmers
12.	District Level Bank Committee	Under PMFBY scheme, conducted awareness camps, rallies among both loanee and non loanee farmers and gave knowledge about the detailed procedure to fetch the premium under this scheme with the collaboration of banks (Agriculture Field Officers)
13.	Krishak Vikas Associations (KVAs)	Execute the work plans made under the PMKSY in which community and individual based water harvesting structures to be made with the collaboration of the soil conservation wing.
14.	Farmers	Active participation in the organized trainings, camps, rallies, demonstrations and taking the benefit of these schemes

Power and Interest of the stakeholders regarding Climate Smart Agriculture Programmes/schemes (PMFBY, PMKSY, NMSA) in districts Bilaspur and Hamirpur of Himachal Pradesh

The stakeholders involved in the above schemes have their own power and interest in doing the activities involved. From the fig. 3, it is interpreted that the nodal agency SDA is implementing all these schemes with the collaboration of the Krishak Vikas Association (KVA) and extension officers. State department lies in a high power area within the district to monitor, evaluation and management of resources worked under these schemes. It is clearly revealed from the fig. 3 that the stakeholders viz., extension officers (ADOs, HDOs, AEOs and HEOs) lie in between the power-interest grid which shows their equal participation of the farmers and the management committee. State agriculture university with the collaboration of KVKs and SDAs have been doing monitoring and evaluation of all the activities done under these schemes. It is also interpreted that KVAs, input dealers and the farmers lie within the high interest low power area of power-interest grid in problem analysis and solving these problems. Farmers have highest interest as they are the active participants in doing all the activities of the schemes.

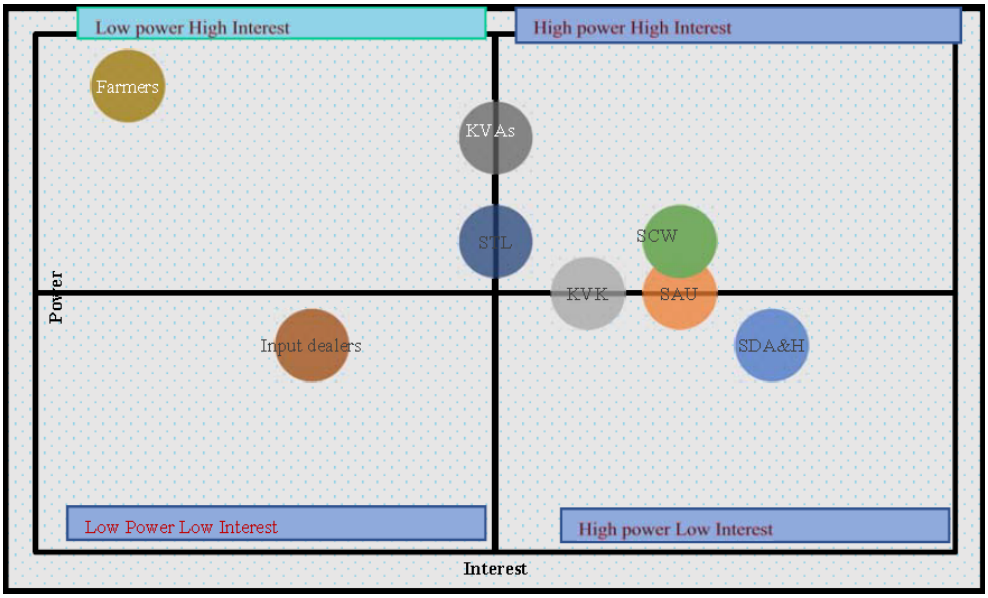

Fig. 3: Power-interest grid of stakeholders involved in CSA programmes (NMSA, PMKSY, PMFBY)

Relationship/collaboration analysis of the stakeholders involved in the CSA programmes (NMSA, PMKSY, PMFBY)

The actor linkage matrix in Table 10 reveals that all the stakeholders involved in these CSA programmes a have strong collaboration/relationship with SDA&H in implementation, planning and execution of all the activities while SAU (CSKHPKV, Palampur) and KVK, Bara (Hamirpur) have weak relationships with other stakeholders as these have been involved in monitoring and evaluation of all the proceedings and activities of CSA projects.

Table 10: Actor-linkage matrix of the stakeholders involved in CSA programmes (NMSA, PMKSY, PMFBY)

Stakeholders	SDA&H	SAU	KVK	SMS	Dos	SCW	STL	ID	KVAs	Farmers
SDA&H	-	S	S	S	S	S	S	M	M	M
SAU	S	-	S	M	M	W	W	W	W	W
KVK	S	S	-	M	M	M	M	M	M	M
SMS	S	M	M	-	S	S	S	M	M	M
Dos	S	W	M	S	-	S	S	S	S	S
SCW	S	W	W	S	S	-	S	S	S	S
STL	S	W	W	S	S	S	-	M	S	S
ID	S	W	M	M	M	W	W	-	W	W
KVAs	S	W	M	M	S	S	S	S	-	M
Farmers	M	W	W	M	S	M	S	M	S	-

(Note: Strength of relationships is represented by Strong (S), Medium (M) and Weak (W) SDA&H-State department of agriculture and horticulture, SAU- State Agriculture University, KVK- Krishi Vigyan Kendra, SMS-Subject Matter Specialist, Dos-Department officers, SCW-Soil Conservation wing, STL-Soil Testing Laboratories, ID: Input Dealers, KVAs: Krishak Vikas Association)

On the other hand, extension officers like SMSs, Dos (ADOs, AEOs, HDOs and HEOs) have a strong relationship with both SDA&H and Farmers in identifying and solving the issues of weather variability at village level. The Krishak Vikas Associations and farmers have weak relationships with input dealers while strong relationships with the implementing agency to get all the benefits of the CSA program and work accordingly.

E. Himachal Pradesh Crop Diversification Promotion Project, JICA

Crop diversification is one of the most important climate smart agriculture practice to adapt various weather variability and continuously changing atmosphere. This project aims at promoting crop diversification in the target area of five districts -Bilaspur, Hamirpur, Kangra, Mandi and Una. And the districts,Hamirpur and Bilaspur of HP comes under category III having large potential for area expansion for crop diversification.

Following stakeholders involved under this project at district level:

Executive Committee

- Chairperson, Secretary (Agriculture), H.P.
- State Department of Agriculture (SDA-a nodal agency)

State Project Unit (SPMU, Hamirpur)

- Project director
- Deputy project director
- SMS

- GIS operator
- Government institutions (SAMETI, KVK, Universities)
- Supporting unit

District Project Management Unit (Hamirpur)

- District project manager
- Subject matter specialists
- MIS and GIS operator
- Assistant engineers (soil and water conservation)

Block Project Management Unit (Hamirpur and Bilaspur)

- Block project manager
- ADOs, AEOs, Draftsnman
- Surveyors
- Self-help groups
- 19 SHGs in BPMU, Bilaspur
- 20 SHGs in BPMU, Hamirpur
- KVA (Krishak Vikas Association)
- 19 KVAs in BPMU, Bilaspur
- 20 KVAs in BPMU, Hamirpur
- Farmers groups
- 19 Farmer groups in BPMU, Bilaspur
- 19 Farmer groups in BPMU, Hamirpur

Table 11: Stakeholders with their specific roles under HP-CDP JICA Project

Sl. No.	Name of the stakeholder	Specific Role
1.	Executive Committee	Submission of annual plan, report, financial statements to governing council
2.	State level PMU	• Budget allocation • Progress and budget control • Baseline survey and monitoring • Annual plan, DPR, DD and reporting the progress • Survey and design • Assisting DPMUs in: • Overall management, monitoring and reporting • Formulating guidelines, manuals, design criteria • Technical quality control
3.	District Level PMU	Management of district level activities Capacity development • Strengthening of Research-extension-farmer linkage • Organize joint field visit with SPMU • Initiate Public private partnership

4.	Block level PMU	• Training and supervise the field activities • Facilitation of the activities like making of self-help groups, farmers • groups etc. • Technical support for the group management • Provide trainings and technical support • Provide supervision on construction work • Technical support on irrigation facilities • With the collaboration of contractor's construction of main irrigation facilities and access farm road

Table 12: Activities Taken under the CSA programme (HP crop diversification, JICA)

Sl. No.	Component	Particulars of Activity
1.	Infrastructure development and improvement	• Construction and improvement of the minor irrigation system like flow irrigation, lifting irrigation, deep tube well, shallow tube well system • Construction of plain terrain, sub mountainous terrain and its improvement • Demonstration on construction of micro-irrigation system • Induction workshop for community motivators • Awareness camp involving the community • Formation and formalization of the farmers group in which workshop of the group to develop objectives and norms, training to the management committee (MC) members on role and responsibility, exposure visit to MC members to working units in other states were taken up • Capacity building of farmers' groups on participatory management processes and institutional development in which trainings of MC and women members, SHG members, workshops of SHG members, workshop on resource mobilization and revenue collection, etc. • Workshop to discuss principal and practices of irrigation and water management, training on microplanning tools and techniques • Promotion of federation of farmers groups' in which workshop for cluster federation development, efficiency development of members etc.

2.	Institutional development (Farmers support)	• Orientation and needs assessment • Farm management • Training of book-keeping, budgeting and monitoring • Preparation techniques • Training on water saving and soil conservation • Training on organic fertilizer and application • Assistance for promotion of vermi-compost • Exhibitions, kisan melas and vegetable shows • Training in application of fertilizer and micro-nutrients with efficient micro-irrigation systems • Cultivation practice: - Training on strategic vegetables growing i.e., cauliflower, tomato, potato and peas and exotic vegetables growing - Training on insect pest management - Training on micro-irrigation and poly house - Training on post-harvest technique

SUCCESS STORY (HPCDP, JICA)

FARMERS OF BAHLSEENA ARE PRODUCING CASH CROPS AFTER GETTING IRRIGATIONS AND TRAINING PROGRAMMS

SUB-PROJECT BAHLSEENA

TEHSIL, DISTT.	JHANDUTTA, BILASPUR
LOCATION	NEAR BERTHIN
COMMAND AREA	26 HACTARE
COST OF PROJECT	65.55 Lakhs
NO. OF BENEFICIARIES	56
KVA FORMED ON	JANUARY 29, 2015

In the sub-project area only 5 per cent of cultivated area had irrigation facilities and rest of the area was dependent on rain for irrigation.. The erratic rains had the bearing on the crops. Keeping in mind the objective of the Himachal Pradesh Crop Diversification Promotion Project (HPCDP) i.e to bring more and more area under irrigation so that farmer can grow more vegetables to raise the income of farmers, the project officials of the BPMU, Bilaspur took the stock of the situation. The main source of irrigation in this scheme was old Dugh Nallah. The farmers of Bahlseena were dependent on traditional farming before the commencement of HPCDP project and main crops of that area were wheat and maize. The area under vegetable cultivation was very less. At first, BPMU, Bilaspur started the survey of the scheme. While survey was being done, the officials formed KVA and 1 SHG, simultaneously, the crop diversification plan was also chalked out with the help of the farmers. Besides these, various training camps

were also organized for the farmers to make them aware about CD plans and functioning of the KVA and the SHG. Exposure visits were also organized by the extension workers. KVA members and motivators visited to Palampur and Sundernagar to understand the concept of crop diversification and how to maintain accounts, budgeting and farmer records. Training on seedling raising by organic fertilizers was also organized by the extension officers. Farmers took advantage of this training and grown nursery of crops like chili, cucurbits and early cauliflower. The farmer here were also encouraged for organic farming by conducting training of organic pest and diseases control & Integrated Pest Management. During this training farmers were told about some of organic preparations, cultural methods to control various diseases and insect- pests, discussed IPM in detail. They were provided some organic crop protector, melia extract, eupatorium extract, palam trap to control various insect pests. 12 vermi-compost pits have been constructed, provided the grant of Rs. 7800 per pit. The farmers at sub- project Bahlseena are now growing vegetables in large scale. The vegetable cultivation is being done in 1.6 hectares, i.e. 6.15 per cent of the total area during the first season which fulfills the objectives of HPCDP-JICA-ODA project. They are also dedicated to grow morevegetables in the coming season. (the box needs to be formatted to view entire text in the bottom)

One of the progressive farmer Sh. Jodh Singh raised nursery of cucurbits like bittergour, bottlegourd, cucumber, pumpkin and solanaceous crops like chilli, brinjal, tomato etc,. and sold them of around 6000 Rs. during this Kharif season. He had alsoearned nearly Rs. 20,000 from cucumber sown in polyhouse

Relationship/collaboration analysis of the stakeholders involved in the CSA programme (HP Crop Diversification project):

The actor-linkage matrix in Table 13 interprets that in the execution of this crop diversification project, the execution committee chairperson i.e., nodal agency, the State Department of Agriculture (SDA) has strong relationships with State Project Management Unit (SPMU) followed by medium collaboration with District Project Management unit (DPMU).

Table 13: Actor-linkage matrix of the stakeholders involved in CSA programmes

Stakeholders	SDA	SPMU	DPMU	BPMU
SDA	-	S	M	W
SPMU	S	-	S	M
DPMU	M	S	-	S
BPMU	W	M	S	-

[Note: Strength of relationships is represented by Strong (S), Medium (M) and Weak (W)
SDA-State Department of Agriculture, SPMU- State Project Management Unit, DPMU-District Project Management Unit, BPMU-Block Project Management Unit]

There is no relationship of the executive committee with Block Project Management Unit. While SPMU has a strong relationship with the district level management unit to do the activities at district level and make progress reports of these activities. At block level, BPMU has strong collaboration with DPMU for installation of infrastructures for micro irrigation systems and supporting extension services at village level.

Power-Interest grid of the stakeholders involved

From the fig. 4, it is clearly interpreted that the stakeholders viz., state department of agriculture and the state project management unit of both the districts lies in a high power area of power-interest grid as per the opinion of the other stakeholders as these led to execution, implementation and overall management of the crop-diversification project and also allocates the funds to DPMU Bilaspur and Hamirpur. On the other hand, all the stakeholders of BPMU viz., project manager, ADOS and AEOs, KVAs, self-help groups, farmers lie in a high interest area as those involved in the facilitation of the activities, supervision, conducting of income generating activities etc., under this crop diversification project.

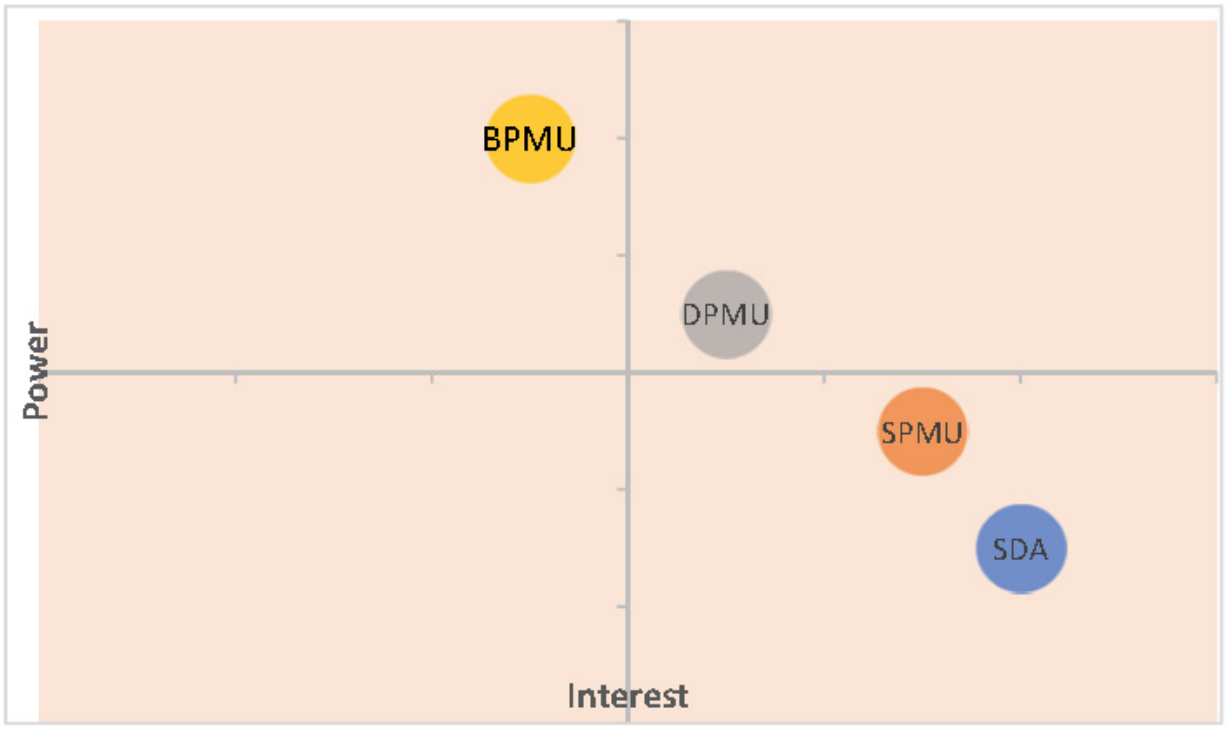

Fig 4: Power-interest grid of stakeholders in HP-JICA project (CSA)

Distribution of the services to the beneficiaries under the CSA programmes:

Under the CSA projects and programmes, the services like inputs and extension services have been provided to the farmers. The inputs like seeds of crops (wheat, maize, paddy) have been provided by the input dealers at the subsidized rate and seedlings of fruits and vegetables have been also

Table 14: Distribution of the services under all CSA programmes:

S. No.	Component	Services	Organizers and Collaborators	Beneficiaries
1.	Inputs	• Seeds • Agrochemicals • Seedlings • Fruit-fly traps • Water harvesting structures • Farm Implements • Soil testing and soil health cards • Crop insurance (kisan credit cards)	Traders, Input dealers, State agriculture university, Agriculture Engineering Department, soil testing laboratories, soil conservation wings, banks etc.	Farmers
2.	Extension Services	• Trainings • Demonstrations • Exposure visits • Exhibitions • Kisan Melas • Field day • Awareness camps • Rallies • Monitoring and Evaluation	SDA, KVK, Line departments, soil testing laboratories, soil conservation wing, SAMETI, Mashobra SAU, ATARI, Ludhiana, development officers (ADOs, AEOs, ATMs and BTM) etc.	Farmers, self-help groups, KVAs and Extension Officers

provided to grow off-season crops under polyhouse cultivation to fetch a high marketing price. Besides these inputs, agrochemicals have also been provided to the farmers at agriculture sale centers at block level. Under water management programmes the services like construction of micro irrigation projects, water harvesting structures on a community basis in the target villages have been provided to the farmers which led to increase their adaptability towards rainfed farming. Under soil conservation projects, soil testing has been done in the farmers' fields and soil health cards were provided to enable the farmers to use manures and fertilizers judiciously according to the requirement of the crops. Under insurance scheme, loanee farmers have been given a 50 percent premium on the crops like maize, wheat, potato in both the districts of Himachal Pradesh through banks in which farmers have been given Kisan credit cards. Other services like trainings at various levels discussed earlier, demonstrations, exposure visits, exhibitions, kisan melas, field days, monitoring and evaluation of all these activities under these programmes have been given to the farmers with collaboration of extension officers (Table 14 and 15).

Table 15: Information sharing and ICT platform in these CSA programmes

S. No.	Stakeholder	Role and collaboration
1.	Availability of seeds, seedlings, pesticides, farm implements, tools etc.	• Personal Contact method by village level committees • Mobile • Opinion leaders
2.	Sowing time, irrigation requirement, insect-pest management, weather forecasting messages etc	• Mobile, m-kisan portal, personal contact, internet, friends etc.
3.	Trainings, demonstrations, Kisan melas, exposure visits, field days etc.	• Newspaper, articles, village level extension workers etc.

3. Incentives and barriers in adoption of climate smart agriculture

Barriers in the adoption of Climate Smart Agriculture Practices:

1. Lack of space on the small land holdings for installing water harvesting structures particularly in rainfed areas
2. Lack of labour availability to carry out the construction of the irrigation structures and taking out various agronomic practices
3. Inaccessibility of the good quality inputs by the farmers from the input dealers and traders
4. As agriculture is the secondary occupation for most of the farmers in both the districts, so lack of interest acts as the barrier in taking out the CSA practices in the farmers' fields
5. Another barrier is poor market facilities especially for fruits and vegetables grown under CSA programmes
6. Lack of access to credit facilities for insurance of the crops like wheat, maize, paddy and potato in both the districts
7. Another big barrier i.e., conflicts exist among the farmers regarding the decision for taking out the extension activities like demonstrations, training camps at village level which led to social and political problems in that particular villages

Incentives and benefits in the adoption of climate smart agriculture practices

1. Continious assistance from the project in terms of investment on construction, providing the resources, capacity building, demonstrations, exhibitions etc. on CSA practices on farmers' fields
2. Lower cost of initial investment to install the polyhouses and water harvesting structures under water and soil management programmes
3. Success stories and best farmer awards under various CSA programmes also act as the incentives for the farmers
4. CSA programmes provide site specific nutrient management, precision water management (micro-irrigation), seed/fodder banks power with value added weather forecasts, skill development, ICT based advisories and capacity development & knowledge sharing

Recommendations

- Block level and village level extension functionaries should dedicate more time to the inception of the project, which could provide adequate opportunity for the project team to connect well with the local community and establish effective collaboration with other stakeholders in the project.
- More awareness and rallies/campaign should be organized by the Krishak Vikas Associations and village level committees in handling the temperature and humidity sensitive agricultural produce specifically in vegetables and fruits.
- Input dealers/traders and agriculture sale centers should focus on quality and timeliness of inputs.
- The focus should be on quality of inputs and mitigation of price fluctuation through measures such as contract farming.
- Development of multipurpose market yard complexes with cold chains (for potato and tomato) in both the districts.
- Farmer-farmer dissemination of promising and improved CSA practices should be initiated so that farmers can get the detailed information and knowledge regarding climate change and its adaptation practices at field level.
- Strengthening of reward mechanism is required so that non-participating farmers be periodically allowed to visit model farms maintained by participating farmers and ensure that those farmers who are not necessarily in groups are also adopting climate smart agriculture practices.
- This study also recommends that the implementing agencies with the collaboration of govt. extension officers should continue the work in those locations of the pilot site that yet to be reached.
- As recommended by the farmers that there should be a collective action to mobilize resources (financial) through community based construction of water harvesting structures, cost sharing and group credit access.

Conclusions

1. This study established the mixed results of the stakeholders' analysis working under the CSA programmes (irrigation projects, sustainability projects, diversification projects, insurance schemes) and the adoption determinants i.e., barriers and incentives while adopting these CSA practices.
2. The findings clearly revealed that the stakeholders viz., Govt. institutions (SAU and ZRS), state department of agriculture and other line departments, research institutions (KVK), development officers (ADOs and AEOs), extension officers (AEOs and VLWs), farmers associations, self-help groups, input dealers and traders, NGOs, Krishak Vikas associations have been involved either directly or indirectly to develop, plan, execute, implement and management of all the activities of CSA programmes.
3. The activities viz., exposure visits, field days, demonstrations and trainings on method of doing all the CSA practices like vermicomposting, mulching (plastic and biomass) for moisture conservation, crop diversification, drought tolerant varieties, fodder cultivation, breed upgradation and their preventive vaccination, institutional intervention like climate literacy through village level weather station, providing seed banks, community nursery preparation etc., have been organized for the farmers through these programmes.
4. While mapping of the stakeholders by power-interest matrix method, it is clearly revealed that the stakeholders viz., SAUs and research stations, state department of agriculture and other line departments, KVKs, KVAs, lie in a high power area while the stakeholders at block and village level lie in high interest areas of power-interest grid.
5. It is concluded from the actor-linkage matrix that the state and district level stakeholders have strong relationship among themselves in development, formulation, implementing and evaluation of all the activities. CSA programmes and also the stakeholders at block and village level have strong relationship amongst themselves in identifying and solving the problems of weather variability in the target area.
6. The services like distribution of inputs, i.e., seeds, pesticides, seedlings, construction of water harvesting structures, farm implements, crop insurance, etc., and organizing extension activities have been provided to the farmers under the CSA programmes for adaptation ad mitigation of climate change effects.
7. Monitoring and evaluation of all the CSA activities and proceedings have been done by the implementing agency with the collaboration of 3rd party i.e., SAUs, ZRS, ATARI etc.
8. Agro-advisories viz., sowing time, irrigation time, availability of inputs, weather forecasting messages have been given to the beneficiaries through m-kisan portal, a personal contact method by extension officers, mobile, newspaper, progressive farmers, neighbors etc.
9. Lack of interest in the farmers and labour unavailability have been identified as the barriers in adopting the CSA practices.
10. Under irrigation projects another barrier arises on the decision of demonstration site in the farmers' fields which created the political and social problems among the farmers.

References

Aberman, N., Birner, R., & and Ali, S. (2011). A Stakeholder Map for Climate Change Adaptation in Bangladesh's Agricultural Sector. unpublished Unpublished report for the project on Enhancing Women's Assets to Manage Risk under Climate Change: Potential for Group Based Approaches. IFPRI, Washington, DC.

Anderson, S., Khan, F., Robledo, C., & and Roth, C. (2016). Evaluation of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Anonymous. (2005). What's the Difference Between Weather and Climate? Retrieved from https:// www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.htmlon 12/02/2017

Anonymous. (2009). Climate Variability and Climate Change. Retrieved from http://www.mise agrant. umich.edu/downloads/climate/11-703-Climate-Variability-and-Climate-Change.pdf.

Anonymous. (2011). What Are Climate and Climate Change? Retrieved from https://www. nasa.gov/ audience/forstudents/5-8/features/nasa-knows/what-is-climate-change-58.htmlon.

Anonymous. (2012) Climate Change. Retrieved from https://en.wikipedia.org/wiki/Climate_ change.
Anonymous. (2013). Guide To Integrated Regional Vulnerability Assessment (Irva) For Climate Change. Office of Environment and Heritage, Sydney South, Australia. pp 23-24.

Bayala, J., Zougmoré, R., Ky-Dembele, C., Bationo, B. A., Buah, S., Sanogo, D., and Kalinganire, A. (2016). Towards Developing Scalable Climate-smart Village Models: Approach and Lessons Learnt from Pilot Research in West Africa. ICRAF Occasional Paper 25, International Centre for Research in Agroforestry, Nairobi, Kenya.

Branca, G., Tennigkeit, T., Mann, W., & and Lipper, L. (2012). Identifying opportunities for climate-smart agriculture investment in Africa (p. 132). Rome, Italy: Food and Agriculture Organization of the United Nations.

Brown, M. E., & and Funk, C. C. (2008). Food Security under Climate Change. NASA Publications 131. Retrieved from http://digitalcommons.unl.edu/nasapub/131.

Butler, J. R. A., Wise, R. M., Skewes, T. D., Bohensky, E. L., Peterson, N., Suadnya, W., and Bou, N. (2015). Integrating Top-down and Bottom-up Adaptation Planning to Build Adaptive Capacity: A structured learning approach. Coastal Management, 43(4): 346-364.

Carter, J. (2009). Stakeholder mapping for Climate Change Adaptation. Manchester, EcoCities project, The University of Manchester, Manchester, UK.
Chatrchyan, A. M., Erlebacher, R. C., Chaopricha, N. T., Chan, J., Tobin, D., & and Allred, S. B. (2017). United States agricultural stakeholder views and decisions on climate change. Wiley Interdisciplinary Reviews: Climate Change, 8(5).

Corfee-Morlot, J., Berg, M., and Caspary, G. (2003). Exploring Linkages between Natural Resource Management and Climate Adaptation Strategies. Working Party on Global and Structural Policies and Working Party on Development Cooperation and Environment. Organisation for Economic Co-operation and Development, Paris.

Dinesh D, Frid-Nielsen S, Norman J, Mutamba M, Loboguerrero Rodriguez AM, Campbell BM. (2015). Is Climate-Smart Agriculture effective? A review of selected cases. CCAFS Working Paper no. 129. Copenhagen, Denmark: CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS).

FAO. (2014). Transitioning towards climate-smart agriculture in Kenya. P[policy brief]. Food and Agriculture Organization of the United Nations, Rome. (available atRetrieved from www.fao.org/3/a-i4259e.pdf.).

Füssel, H. M. (2007). Vulnerability: A Generally Applicable Conceptual Framework for Climate Change Research. Global Environmental Change, 17(2): 155-167.

Hall A. J., Yoganand, B., Sulaiman R.V., Rajeswari Raina, S., Shambu Prasad, C., Naik Guru ,C. and Clark, N. G. (eds.). (2004). Innovations in innovation: Reflections on partnership, institutions and learning. Crop Post-Harvest Programme (CPHP), South Asia, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and National Centre for Agricultural Economics and Policy Research (NCAP). Pp: 252.

Heltberg, R. and Bonch-Osmolovskiy, M. (2011). Mapping vulnerability to climate change. World Bank Policy Research Working Paper No. 5554, World Bank, Washington, DC, USA.

Hiremath, D. and Shiyani, R. L. (2013). Analysis of vulnerability indices in various agro-climatic zones of Gujarat. Indian Journal of Agricultural Economics, 68: 122-37.

Houghton, J. T. (2004). Global Warming: The Complete Briefing. Cambridge University Press, Cambridge, UK. Pp 74-87.

Hundal, S. S. and Kaur, P. (2007). Climatic variability and its impact on cereal productivity in Indian Punjab. Current Science, 92: 506-12.

Iizumi, T. and Ramankutty, N. (2015). How do weather and climate influence cropping area and intensity? Global Food Security, 4: 46-50.

Iyengar, N. S. and Sudarshan, P. (1982). A method of classifying regions from multivariate data. Economic and Political Weekly, 17(51): 2048-2052.

Jamir, C., Sharma, N., Sengupta, A. and Ravindranath, N. H. (2013). Farmers' vulnerability to climate variability in Dimapur district of Nagaland, India. Region Environ Change 13: 153-164.

Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M., and Hottle, R. (2014). Climate-smart Agriculture for Food Security. Nature Climate Change, 4(12): 1068.

Long,T. B., Blok, V., and Coninx, I. (2016). Barriers to the Adoption and Diffusion of Technological Innovations for Climate-smart Agriculture in Europe: Eevidence from the Netherlands, France, Switzerland and Italy. Journal of Cleaner Production, 112: 9-21.

Madukwe, M. C., and Obiora, C. J. (2012). Identifying and Mapping Linkages between Actors in the Climate Change Innovation System. Journal of Agricultural Extension, 16(1): 59-67.

Meinzen-Dick, R., Bernier, Q., Haglund, E., Markelova, H., and Moore, K. (2012). Identifying the Institutions for Climate-Smart Agriculture. International Research Workshop on Institutions for Inclusive Climate-Smart Agriculture, Nairobi, Kenya. Pp. 10-13.

Mutoko, M. C., Rioux, J., and Kirui, J. (2015). Barriers, Incentives and benefits in the Adoption of Climate-smart Agriculture: Lessons from the MICCA Pilot Project in Kenya. Food and Agriculture Organization of the United Nations FAO, Rome.

Mwongera, C., Shikuku, K. M., Twyman, J., Läderach, P., Ampaire, E., Van Asten, P., and Winowiecki, L. A. (2017). Climate Smart Agriculture Rapid Appraisal (CSA-RA): A Tool for Prioritizing Context-specific Climate Smart Agriculture Technologies. Agricultural Systems, 151: 192-203.

Nelson, G. C., Rosegrant, M. W., Palazzo, A., Gray, I., Ingersoll, C., Robertson, R., and Msangi, S. (2010). Food Security, Farming, and Climate Change to 2050: Scenarios, Results, Policy Options (Vol. 172). International Food Policy Research Institute, Washington DC.

Neufeldt, H., Jahn, M., Campbell, B. M., Beddington, J. R., DeClerck, F., De Pinto, A., and LeZaks, D. (2013). Beyond climate-smart agriculture: Toward safe operating spaces for global food systems. Agriculture & and Food Security, 2(1): 12.

Newaj, R., Chavan, S. B., and Prasad, R. (2015). Climate-smart Agriculture with Special Reference to Agroforestry. Indian Journal of Agroforestry, 17(1): 96-108.

Nyasimi M, Amwata D, Hove L, Kinyangi J, Wamukoya G. 2014. Evidence of Impact: Climate-Smart Agriculture in Africa. CCAFS Working Paper no. 86. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Parikh, J. K., & and Parikh, K. (2002). Climate change: India's Perceptions, Positions, Policies and Possibilities. OECD Paper Series on Climate Change and Development. http://www.indiawaterportal.org/sites/indiawaterportal.org/files/1934784.pdf

Parikh, J., Sharma, A., Singh, C., Kaushik, A., & Dhingra M 2014. Final Technical Report on Socio Economic Vulnerability of Himachal Pradesh to Climate Change. Integrated Research Cation for Development ()

Prasad, Y. G., Maheswari, M., Dixit, S., Srinivasarao, Ch., Sikka, A. K., Venkateswarlu, B., Sudhakar, N., Prabhu Kumar, S., Singh, A. K., Gogoi, A. K., Singh, A. K., Singh, Y. V. and Mishra, A. (2014). Smart Practices and Technologies for Climate Resilient Agriculture. Central Research Institute for Dryland Agriculture (ICAR), Hyderabad. Pp-76.

Rama Rao, C. A., Raju, B. M. K., Subba Rao, A. V. M., Rao, K. V., Rao, V. U. M., Kausalya, R., Venkateswarlu, B. and Sikka, A K. (2013). Atlas on Vulnerability of Indian Agriculture to Climate Change. Central Research Institute for Dryland Agriculture, Hyderabad. Pp - 116.

Rao, K. P. C., Hansen, J., Njiru, E., Githungo, W. N., and Oyoo, A. (2015). Impacts of Seasonal Climate Communication Strategies on Farm Management and Livelihoods in Wote, Kenya.

Reid, H., Alam, M., Berger, R., Cannon, T., Huq, S., and Milligan, A. (2009). Community-based Adaptation to Climate Change: An overview. Participatory Learning and Action, 60(1): 11-33.

Rioux, J., Gomez San Juan, M., Neely, C., Seeberg-Elverfeldt, S., Karttunen, K., Rosenstock, T., and Masoud, T. (2016). Planning, Implementing and Evaluating Climate-smart Agriculture in Smallholder Farming Systems. Mitigation of Climate Change in Agriculture Series (FAO) No. 11.

Schmeer, K. (1999). Stakeholder Analysis Guidelines: Policy Toolkit for Strengthening Health Sector Reform, Pp 1-33.

Schmidhuber, J., & and Tubiello, F. N. (2007). Global Food Security under Climate change. Proceedings of the National Academy of Sciences, 104(50):, 19703-19708.

Selvaraju, R., Gommes, R., and Bernardi, M. (2011). Climate Science in Support of Sustainable Agriculture and Food Security. Climate Research, 47(1/2): 95-110.

Srivastava A 2015. Vulnerability to Climate Change & Variability: an Investigation into Macro & Micro Level Assessments–A case Study of Agriculture Sector in Himachal Pradesh, India. A 2015 report on the Patterns of Disaster Risk Reduction Actions at Local Level

Williams, T. O., Mul, M., Cofie, O., Kinyangi, J., Zougmore, R., Wamukoya, G., Nyasimi, M., Mapfumo, P., Speranza, C.I., Amwata, D., Frid-Nielsen, S., Partey, S., Girvetz, E., Rosenstock, T., Campbell, B. M. (2015). Climate Smart Agriculture in the African Context. Background Paper. Feeding Africa Conference 21-23 October 2015.

World Bank. (2015). The growth report (Strategies for sustained growth and inclusive development, commission on growth and development , Wasington D. C.)

National Institute of Agricultural Extension Management (MANAGE)
(An organisation of Ministry of Agriculture and Farmers' Welfare, Govt. of India)
Rajendranagar, Hyderabad – 500 030, Telangana State, India
www.manage.gov.in