Extension NEXT

Bulletin No. 3, 2018

Extension and Advisory Services for

Climate Smart Agriculture

Published by

National Institute of Agricultural Extension Management (MANAGE)
(An Organization of Ministry of Agriculture and Farmers Welfare, Govt. of India)
MANAGE-Centre for Agricultural Extension Innovations, Reforms and Agripreneurship (CAEIRA)
Rajendranagar, Hyderabad – 500 030, Telangana State, India

About the Publication

This bulletin series is aimed at imparting better understanding about recent developments in agricultural extension. It also intends to develop basic understanding about the role of extension in agricultural and allied sectors and start a dialogue on how to make extension efforts to contribute for better impact. Each issue of the bulletin will take up a single topic and discuss merits and implications. The target audience for the bulletin are extensionists, extension managers and administrators, extension students, policy makers, and agricultural practitioners.

Authors

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

Dr. Sankri Karthikeyan
MANAGE Fellow, Centre for Agricultural Extension Innovations, Reforms, and Agripreneurship
National Institute of Agricultural Extension Management (MANAGE)
Rajendranagar, Hyderabad, Telangana, India
e-mail: sankri.karthikeyan@manage.gov.in/ sankrikarthikeyan@gmail.com

Mr. Vincent A
MANAGE Intern, Centre for Agricultural Extension Innovations, Reforms, and Agripreneurship
National Institute of Agricultural Extension Management (MANAGE)
Rajendranagar, Hyderabad, Telangana, India
e-mail: vincentvinil15@gmail.com

Layout Design

Ms. Niharika Lenka

Disclaimer

Correct citation: Saravanan, R. Karthikeyan, S. and Vincent, A. 2018. Extension and Advisory Services for Climate Smart Agriculture. MANAGE Bulletin 3 (2018), National Institute of Agricultural Extension Management (MANAGE), Hyderabad, India.

Message from Director General, MANAGE

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

Extension NEXT is a bulletin published by MANAGE to highlight the concepts which extension personnel today need to focus more.

Gone are the days where seasons are well defined, rainfall is expected as per the schedule. In the present scenario, all the weather parameters including temperature, rainfall are varying with unpredictable patterns resulting in flash food, drought and raise in sea-level etc., This drastic changes in climate are affecting agriculture and thus livelihood security of Indian farmers. Though, there should be a long term policy to combat situation handling the causative factors affecting climate like deforestation, industrialization, Vehicular pollution, but there is an immediate need enabling the farmers to face the situation by duly modifying present agriculture into 'Climate Smart Agriculture'. This involves selection of appropriate crops, appropriate varieties, and agrarian practices including integrated farming systems. In order to facilitate farmers to take appropriate decision, extension advisory services need to update farmers on minute expected changes in climate and its implication, weather forecast, so that farmer can plan field operators accordingly.

This bulletin definitely will sensitize policymakers, extension personnel and farmers about challenges in agriculture due to climate change and need to gear upto the situation otherwise the future of farmers and all those dependents on agriculture will be bleak.

This bulletin reviews briefly about "Farmer Advisory Services" existing in many countries and narrates how information is quickly transferred to farmer by the extension functionaries. There is also a need for researchers to focus on 'Climate Smart Agriculture' and develop relevant technologies to face new challenges being posed by ever degrading climate.

I hope this bulletin is handy in providing good information about 'Climate Smart Agriculture' and skills required for extension officials, the administrators and policymakers to handle the situation effectively and also a need for placing appropriate system in place.

Any suggestion in this regard are most welcome.

(V. Usha Rani)

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Extension and Advisory Services for Climate Smart Agriculture

In this issue

Abbreviations and Acronyms

AFOLU – Agriculture, Forestry and Other Land Use
AR4D – Agricultural Research for Development
CCAFS – Climate Change Agriculture and Food Security
CGIAR - Consultative Group for International Agricultural Research
CICSS - Cornell Institute for Climate Smart Solutions
CLAP - Local Early Warning Committees
CMP - Comprehensive Management Plan
COP – Conference of Parties
CSA – Climate Smart Agriculture
CSV - Climate Smart Village
EPIC – Economics and Policy Innovations for Climate Smart Agriculture
FAO – Food and Agriculture Organisation
FAOSTAT - Food and Agriculture Statistics
GACSA – Global Alliance for Climate Smart Agriculture
GHG – Green House Gas
GLAM - Groups for Local Meteorological Assistance
GCAM - Municipal Rural Meteorological Assistance Groups and
ICAR – Indian Council of Agricultural Research
ICRISAT - International Crops Research Institute for the Semi-Arid Tropics
ICT – Information and Communication Technology
INDC – Intended Nationally Determined Contributions
IPCC - Intergovernmental Panel on Climate Change
LI-BIRD – Local Initiatives for Biodiversity, Research and Development
MICCA – Mitigation of Climate Change in Agriculture
NAMA – Nationally Appropriate Mitigation Actions
NAP – National Adaptation Plan
NGO – Non-Governmental Organisation
NICRA - National Innovations on Climate Resilient Agriculture
PICSA – Participatory Integrated Climate Services for Agriculture
RABIT – Resilience Assessment Benchmarking and Impact Toolkit
UNFCCC – United Nations Framework Convention on Climate Change
USAID – United States Agency for International Development
USDA – United States Department of Agriculture

Introduction

Agriculture is the most vulnerable and sensitive sector affected by climate change because of its dependency on local climate parameters like rainfall, temperature, soil health etc. Impact of climate change on agriculture will be one of the major deciding factors influencing the future food security of mankind on the earth. The estimated impacts of both historical and future climate change on cereal crop yields in different regions indicate that the yield loss can be up to −35% for rice, −20% for wheat, −50% for sorghum, −13% for barley, and −60% for maize depending on the location, future climate scenarios and projected year (Porter et al., 2014).

In Asia, agricultural crop yield are expected to decline by 5-30% by 2050s due to rising temperature in Himalayas and this decline in agricultural yield will lead to food insecurity, which becomes a serious future problem for human beings. Higher temperature eventually reduces yields of desirable crops while encouraging weed and pest proliferation (IPCC, 2007). Increasing the productivity and incomes from smallholder crop, livestock, fisheries and forestry production systems will be key to achieving global food security (FAO and CGIAR, n.d.). Understanding the weather changes over a period of time and adjusting the management practices towards achieving better harvest are challenges to the growth of agricultural sector as a whole.

To alleviate the challenges posed by climate change, agriculture has to become "climate smart". The concept of Climate Smart Agriculture (CSA) was originally developed by FAO and officially presented and at the Hague Conference on Agriculture, Food Security and Climate Change in 2010, through the paper "Climate Smart Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation". Climate Smart Agriculture (CSA) 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 (FAO, 2010).

Despite the recognised importance of Climate Smart Agriculture (CSA), the dissemination and uptake of climate-smart technologies, tools and practices is still largely an ongoing and challenging process. The adaption of climate-related knowledge, technologies and practices to local conditions, promoting joint learning by farmers, researchers, extension personnel and widely disseminating Climate Smart Agriculture (CSA) practices, is critical. CSA approach deals with these interlinked challenges in a holistic and effective manner (Sala et al., 2016).

International attention has led to the development of several CSA initiatives, including the Global Alliance for CSA (GACSA) and the Africa CSA Alliance, etc. Despite this, there is still a growing need for methodologies and approaches that comprehensively combine socio-economic and biophysical realities across scales in order to prioritize, implement and out-scale CSA technologies on the ground in response to current agro-climatic conditions (Cooper et al., 2009).

Climate change, perception of different stakeholders, and impact of climate change: Mitigation and adaptation to climate change

I. Weather

a. Temperature		
Global surface mean ***temperature will rise by 1.1 to 6.4°C*** and warming will be greatest over land and high altitudes	Global	Majra and Gur, 2009
Farmers in the Nile basin of Ethiopia perceived that the temperature has increased	Ethiopia	Deressa et al, 2009
73.2 % of the people in Himalayan region believed that the weather is getting warmer	India	Chaudhary and Bawa, 2011
76.66 % of the farmers held high perception toward change in temperature	Karnataka, India	Shankara et al, 2013
97 % and 63 % of the paddy growers in the villages of Thanthrimale and Mahavilachchiya (Anuradhapura District) admitted that the weather has become worse in the past 20 years	Sri Lanka	Nizam, 2013
62 % of the farmers perceived that the average temperature has increased	Chile	Roco et al, 2015
36 % of the farmers in Villupuram district has said that the ***average temperature is increasing***	Tamil Nadu, India	Dhanasekhar, 2015 in Climate South Asia Network
89 % of the farmers in Kancheepuram expressed that the temperature has increased as they have become exhausted very soon owing to extreme heat and hot wind	Tamil Nadu, India	Dhanya and Ramachandran, 2015
Farmers in the Treasure Valley of USA believed that, there ***would be colder winter and hotter summer*** owing to the climate change	USA	Castellano and Moroney, 2018
In the Iowa state of USA, of the 47 of 51 corn farmers who have admitted climate is changing also held that, the climate change is the natural phenomena/cyclic weather pattern	USA	Houser, 2018

74 % of the household members intended that the temperature has increased	Andean Altiplano, South America	Meldrum, 2018
Farmers in Lower Gweru of central Zimbabwe ascertained that the temperature has been increasing	Zimbabwe	Makuvaro et al, 2018
b. Rainfall		
67.2 % of the general public in Himalayan region expressed that the onset of summer and monsoon has advanced	India	Chaudhary and Bawa, 2011
93 % of the farmers believed that the ***precipitation has decreased***	Chile	Roco et al, 2015
88 % of the farmers in Kancheepuram perceived that the rainfall has been decreasing besides, it has become unpredictable along with dry spells in cropping season	Tamil Nadu, India	Dhanya and Ramachandran, 2015
40 % of the farmers in Villupuram district pointed out that the monsoon has reduced	Tamil Nadu, India	Dhanasekhar, 2015 in Climate South Asia Network
94 % of the farmers believed that the amount rainfall, duration, intensity and rainy days have decreased	Ghana	Limantol et al, 2016
90 % of the farmers in Ethiopia perceived the climate variability	Ethiopia	Belay, 2017
Mixed perception of farmers toward climate change 68.5 % of the farmers held that the temperature has increased whereas 12.3 % of the farmers believed that the temperature has reduced. 12.6 % of them observed that there is no change in climate in Arsi Negelle district of West Arsi Zone, Oromia Regional State of Ethiopia.	Ethiopia	Belay, 2017
71 % of the household members expressed that the rainfall pattern has changed	Andean Altiplano, South America	Meldrum, 2018
Farmers in Lower Gweru of central Zimbabwe ascertained that the rainfall has been decreasing however, it is not consistent with the historical data	Zimbabwe	Makuvaro et al, 2018
c. Floods, Drought and cyclone		
Severe storms (cyclones) will be cause to the livelihoods, infrastructure and exacerbate to the salt water intrusion in storm surges	India	National Intelligence Council, 2009

87 % of the farmers believed that the drought occurrence has become more frequent	Chile	Roco et al, 2015
Farmers in Bundelkhand feel that the drought has increased owing to failure of monsoon	Bundelkhand, India	Sarkar, 2016
Tropical cyclones (Mora), flood and landslides have displaced 8.51 lakh people in Bangladesh, Myanmar	South Asia	Martin, 2017

II. Ocean/seas

a. Sea level rise		
Low lying coastal region in Bangladesh may adversely be affected by the rise in sea level	Bangladesh	Climate south Asia Network, 2018
1.5 Million people need to be relocated owing to sea level rise in the Sundarbans (West Bengal)	West Bengal, India	Climate south Asia Network, 2018
2 of 21 islands of Gulf of Mannar have submerged due to sea level rise	Tamil Nadu, India	Dhanasekhar, 2015 in Climate South Asia Network

III. Natural resources

a. Water, glaciers and snow		
Glacier melts would cause more runoff in the short term but less in the medium and long term	India	National Intelligence Council, 2009
70 % of the locals of the Himalayan regions think that the water sources have become scarce/dwindling	India	Chaudhary and Bawa, 2011
Farmers in Kancheepuram noticed that the water has been dwindling	Tamil Nadu, India	Dhanya and Ram-achandran, 2015
Receding glaciers may adversely affect the irrigation needs according to Shakil Ahmad Romshoo, Professor of Earth Sciences, at the University of Kashmir.	Kashmir	The Third Pole, 2016
Mohammad Shafi Sofi reported that the ***water level in Jhelum has lowered*** ever in the past 34 years	Kashmir, India	Climate south Asia Network, 2017
23 glaciers in the state of Uttarakhand have retreated between 1960 and 2000	Uttarakhand, India	Maccarthy, 2017
Villagers in parts of Uttarakhand have absorbed the ***reduced snow fall*** since 1980s	Uttarakhand, India	Maccarthy, 2017

The ***melting of glaciers in Himalayan mountains*** results in changes in the Indus river water in Pakistan (Banuri)	Pakistan	Banuri, 2018
Bangladesh may be hard hit by the climate change as it has limited control over the 57 trans boundary rivers of India and Myanmar	Bangladesh	Climate south Asia Network (2018)
Siachen glacier has been retreating in an alarming rate i.e. 110 metres a year	Pakistan	Climate south Asia Network, 2018
b. Bio-diversity		
53.2 and 48.8 % of the locals of the Himalayan regions observed that ***the bud burst and flowering have become advanced in several species*** namely, *Magnolia sp., Michelia champaca, Rhododendron spp., Chrysanthemum indicum, Tagetes spp., Prunus persicaand Prunus cerasoides* by one to six weeks.	India	Chaudhary and Bawa, 2011
Reduction in ***number of bees in Nilgiris*** in Tamil Nadu	Nilgiris, Tamil Nadu	Dhanasekhar, 2015 in Climate South Asia Network
Reed beds are declined due to drying up of Sittraru river of Tirunelveli district, which is the important grass for the Islamic community whose livelihoods completely depends on the Reed beds, a solely available material for knitting the mats	Tamil Nadu, India	Venkatesh, 2015
58 % of fishes, birds and animal population have lost and the per cent would reach to 67 % by 2020. Other plants and microorganisms are also being lost at faster pace.	Global	South Asia Network, 2017
22 % of the household members noticed the increased erosion	Andean Altiplano, South America	Meldrum, 2018
c. Forestry		
Scientists estimated that the ***13 % of the carbon emission come from deforestation***	Global	WWF, n.d.
In the Amazon, ***17 % of the forest*** has been lost in the last 50 years	Latin America	WWF, n.d.
Forest fires can cause burns, damage from smoke inhalation and other injurious	Global	Confalonieri et al, 2007

iv. Social

a. Health		
Rodents born disease could increase in India such as leptospirosis, tularemia, and viral hemorrhagic diseases including diseases associated with rodents and ticks, and which show associations with climatic variability, include Lyme disease, tick-borne encephalitis, and Hantavirus pulmonary syndrome.	-	Aron and Patz, 2001
Climate change will cause premature death, increased malnutrition, consequent disorders, increase in people suffering from death, injury from heat waves, storms, fires and droughts, increase in infectious diseases, increase in diarrhoeal disease, increase in cardio-respiratory morbidity and mortality associated with ground level ozone, increase in number of people at risk of dengue	Global	Confalonieri et al, 2007
Lack of water and sanitation in urban slum areas serves as the ***disease reservoir and vectors***, which facilitate the water borne disease and vectors	Global	Confalonieri et al, 2007
Malaria is set to move toward higher altitude and latitude in India owing to climate change	India	National Intelligence Council, 2009
People who are vulnerable to deaths during extreme thermal temperature are the persons with ***pre-existing diseases, cardiovascular and respiratory diseases***	Global	Majra and Gur, 2009
Sea level rise may lead to deaths, injury, reduced availability of fresh water due to sea water intrusion, contamination of water supply due to pollutants from submerged waste dumps, health effect on nutrition due to loss of agricultural land and change of fish catch	India	Majra and Gur, 2009
46 % of the people in Himalayan region reported that ***the increased presence of mosquitoes*** in the villages	India	Chaudhary and Bawa, 2011
Heat waves in Odisha during 1998 and Andhra Pradesh during 2003 have caused 2000 and 3000 deaths	Odisha and Andhra Pradesh, India	Joon and Jaiswal, 2012
1. 6 Lakh people will die every year in India due to reduced food production in the backdrop of Climate change	India	Monte'D, 2016
Climate change may affect the food, fruits %vegetables and red meat availability to people by 3.2 %, 4 % and 0.7 % by 2050.	Global (150 Countries)	Monte'D, 2016

Heart attacks may increase when the temperature swings between 25-40oC	Global	Reford, 2018
The growth of the population reduces the average availability of water every day in Pakistan	Pakistan	Banuri, 2018
b. Pollution		
The increase in ***0.5°C and 2-4°C of temperature*** by 2030 and end of the 21st century in India may lead to increased pollution	India	National Intelligence Council, 2009
Migration of people from Bangladesh is a likely event in the wake of climate change especially owing to climate change	India	National Intelligence Council, 2009
c. Gender		
In Bangladesh, half of the population of the farmers are now women yet their access to fertilisers, fuel, subsides and other government benefits like adaptation of saline and food tolerant varieties owing to lack of Agriculture Input Assistance Card (AIAC), which is mostly registered in the name of men as the agricultural lands are in the name	Bangladesh	Majumder, 2016

V. Agriculture

a. Agronomy, crop production and protection		
54 % of the people observed new crop pests, 38.8 % noticed the occurrence of new weed species namely, abijal and banmara	India	Chaudhary and Bawa, 2011
Farmers in Nagapattinam and Cuddalore have perceived that the rice yield has reduced to 20 % in the past 20 years. E.g. Thennampattinam village (Nagapattinam district) farmers yield has been reduced to 2.5 – 3 tonne/ha from 4.5-5 tonnes/ha	Tamil Nadu, India	Nambi and Bahinipati, 2012
Cent per cent of the farmers expressed that the decrease in yield, income, soil, nutrients and increase in the infestation of pests, diseases and weeds	Karnataka, India	Confalonieri et al, 2007
36 % and 26 % of the rice growers have opted for growing number of different corps and crop rotation respectively	Vietnam	Dang, 2014
Farmers in Kancheepuram reported that the area under paddy has decreased so as the production due to non-availability of water	Tamil Nadu, India	Dhanya and Ramachandran, 2015

26.3 % of the farmers attributed that the crop failure, disease and lowering water availability to climate change	Ethiopia	Kidanu et al, 2016
56 % of the household members observed the increased pest and disease	South America	Meldrum, 2018
Yield of the rainfed crops may be reduced to 50 % in Bangladesh by 2020	Bangladesh	Climate south Asia Network, 2018
By 2030, the yield of the paddy and maize would be reduced to 10 %	South Asia	Climate south Asia Network, 2018
b. Fisheries		
It has been reported that the population of fish has been reduced in the Nagapattinam and Cuddalore districts	Tamil Nadu, India	Nambi and Bahinipati, 2012
Sardines of Arabian Sea have been diminishing due to climate change	Kerala, India	Rajendran, 2016
Fishes have died and stranded in the banks of Jhelum river	Kashmir, India	Climate south Asia Network, 2018
c. Animal Husbandry		
Quality of natural grown fodder has reduced over the period in Sirsi taluk of Uttara Kanada. Besides, many species (90 Nos) which grown in the mela nadu region lost. Besides, 'malnad gidda' local breed has reduced	Karnataka, India	Hegde, 2015
Outbreak of ***Food and Mouth Disease (FMD)*** in cattle was observed in Andhra Pradesh and Maharashtra to the tune of 52 and 84 % due to temperature, humidity and rainfall; ***Mastitis*** increases in dairy animals during hot and humid weather, in turn increases the flies and tick.	India	National Intelligence Council, 2009

Mitigation and adaptation

a. Agronomic practices, crop production and protection		
17 % of the farmers use mixed cropping and mulch and 8 % of farmers go for cover cropping and crop rotation sometime even selling of livestock	Ghana	Limantol et al, 2016
22 % of the farmers in Pakistan have adjusted the sowing time as an adaptation to climate change	Pakistan	Ali and Erenstein, 2017
57.3 % of the farmers have adopted the shift in planting of crop season	-	Njenga et al, 2014

36.7% of the farmers have adopted the mixed cropping, crop rotation, mulching and organic farming	Benin	Fadina and Barjolle, 2018
52 % of the farmers in Kaveta Village have used the animal manures and pesticides as the measures to overcome climate change	Kenya	Mutunga et al, 2017
32 % and 16 % of the farmers in Kaveta Village have shifted to mixed crop and diversification of crops	Kenya	Mutunga et al, 2017
86 % of the farmers in Mikuyuni Village used animal manures	Kenya	Mutunga et al, 2017
71 % of the farmers in Mikuyuni Village have adopted mixed and livestock farming as the mitigation measure	Kenya	Mutunga et al, 2017
50 % of the farmers in Ghoti village (Ahmednagar district) have moved to ***intercropping of Marigold with tomato*** and other vegetables moreover, Indian beans are intercropped with Cluster bean	Maharashtra, India	Leisa India, 2017
Farmers in Uttarakhand have begun to take up cultivation of potato crop in the winter owing to reduced snow fall in the winters for the first time, which otherwise left falllow	Uttarakhand, India	Maccarthy, 2017
No tillage or reduced tillage has increasingly been followed as the adaptation measure by the farmers of Ethiopia	Ethiopia	Belay, 2017
Increased use of inputs has been followed as the adaptation strategy by the farmers of Ethiopia	Ethiopia	Belay, 2017
Mulching of annual crops like Maize and perennials like banana and coffee is predominantly followed by the famers of Uganda	Uganda	Zizinga et al, 2017 and Fadina and Barjolle, 2018
Mixed cropping has been followed by the farmers i.e. Maize–Cassava, Maize–Groundnut, Maize–Bean, Maize–Bean–Cassava to cope with the climate changes in Benin;	Benin, Africa	Fadina and Barjolle, 2018
Yield response of Maize was high to green manures (cowpeas/velvet beans/pigeonpea/lablab/sunhemp) for rotation	Africa	FAO, n.d.
50 (nos) farmers have opted for Integrated Farming System (IFS) in Nandihalli village	Karnataka, India	Kulkarni, n.d

b. Cropping pattern		
Farmers in rural Kenya have abandoned the mono cropping pattern	Rural Kenya	Hassan and Nhemachena. 2008
Considerable number of rice and mulberry farmers in Karnataka have shifted to Ragi and Red gram	Karnataka, India	Shankara et al, 2013
Farmers have shifted to short duration pulse crops such as Black gram, Maize, vegetables and perennial crops like fruit crops, banana and coconut from paddy	Tamil Nadu, India	Dhanya and Ramachandran, 2015
79 % of the farmers in Villupuram district has adopted to Strip cropping to manage drought	Tamil Nadu, India	Arun Nedunchezhian in Climate South Asia Network, 2015
Bangladeshi women farmers have shifted to Maize and Potato from water intensive crop like paddy to avoid the crop loss from the drought, which has become a recurrent in the recent times	Bangladesh	Islam, 2016
25 % of farmers in Pakistan have shifted to new crops	Pakistan	Ali and Erenstein, 2017
Farmers in Ethiopia follow diversification crops to cope with changing climate	Ethiopia	Belay, 2017
Farmers in certain pockets of Uttar Pradesh state ***shift to peppermint*** from traditional sugarcane crop	Uttar Pradesh, India	Tripathi and Mishra, 2017
37.7 % of the farmers have also diversified the crop-livestock	Benin	Fadina and Barjolle, 2018
Farmers select Sorghum, Maize-Millet in the cooler regions of Africa, Maize-Beans, Maize-Groundnut in hot regions; Sorghum, Millet-Groundnut in the conditions of dry climate; Cowpea, Cowpea-Sorghum, Maize-Millet, and Maize in the conditions of medium wet; Maize-Beans and Maize-Groundnut when the weather turns to wet. Besides, farmers shift to heat tolerant crops when the temperature becomes warm.	Africa	FAO, n.d
Farmers in Vietnam have shifted to fruit trees and grapes in the wake of climate induced disaster	Vietnam	FAO, n.d

c. Improved varieties		
59.18 % of the rice growers have changed the rice varieties from long duration to short duration, 16. 32 % of them changed to long duration varieties from short duration varieties	Karnataka, India	Shankara et al, 2013
75 % of farmers have adopted different crop varieties	Ghana	Limantol et al, 2016
15 % of farmers have adopted drought tolerant varieties	Pakistan	Ali and Erenstein, 2017
68 % of the farmers in in Kaveta Village have adopted hybrid crop varieties	Kenya	Mutunga et al, 2017
87 % of the farmers in Mikuyuni Village have used hybrids	Kenya	Mutunga et al, 2017
Farmers in Ethiopia has changed the plant varieties	Ethiopia	Belay, 2017
In Bangladesh, farmers have opted for cultivating Highy Yielding (HYV) rice varieties such as ***BRRI-28, BRRI-29 and BRRI-45*** as a pat of response to climate change	Bangladesh	Alam et al, 2017.
Maize hybrid Longe 9H was adopted by farmers of Uganda as a tolerant hybrid to drought	Uganda, Africa	Zizinga, 2017
BARI Chola-10 a chickpea variety resistant to heat, Botrytis Grey Mold (BGM) and high yielding was released in Bangladesh as the chickpea is the second largest cultivated crop after rice in Bangladesh	Bangladesh	Mishra, 2017
Farmers have also opted for improved ***fruit species and Oil palm***	Benin, Africa	Fadina and Barjolle, 2018
38.3 % of the farmers have adopted the improved varieties	Benin	Fadina and Barjolle, 2018
Farmers in Salikeni village changed their rice varieties to early and later maturity variety	Gambia, Africa	FAO, n.d
Green Super rice, a climate-tolerant rice (Tolerant to floods, drought and increased water salinity), which was demonstrated by the FAO among 500 farmers in Bicol region of Philippines	Philippines	FAO, n.d
NERICA (New Rice for Africa) is the rice variety, which has been adopted by many farmers in African countries owing to its early maturity, weed competitive, tolerant to pests and diseases, drought and iron toxicity.	Africa	FAO, n.d

d. Soil and water conservation		
Farmers in Sweden and Tanzania use cover corps to improve the seedling survival. Similarly, contour plantings, mulching and construction of cutoff drains were used to control erosion in Mbulu highlands	Sweden	Tengo and Belfrage, 2004
Farmers have adopted Compost production and application in Burkina Faso, Tessa planting pit in Niger, Run-off and flood water farming in Ethiopia and stone bunds in Burkina Faso	Africa	FAO, 2011
Crop cover has been taken up as the one of the conservation agriculture in mitigating the adverse climate, in African countries, cowpea, pigeon pea, lablab purpureus, and mucuna pruriens (velvet bean); improved fallows seeded with fast-growing tree species such as sesbania sesbans and gliricidia sepium were adopted	Africa	FAO, 2011
Farmers have adopted rotational grassing in South Africa, stone bunds, soil bunds, grass stripes, waterways, trees and contours are likely measures adopted by farmers in Nile basins of Ethiopia	Ethiopia	Kato et al, 2011
Direct seeding, integrated soil fertility management, ***Minga System of Bolivia*** for drought management and Biochar for absorbing organic and inorganic matter in the agricultural fields are the various measures taken to conserve soil and water	-	FAO, 2013
Considerable number of farmers in Karnataka have constructed ***farm ponds and installed drip irrigation***	Karnataka, India	Shankara et al, 2013
Ponds, Johad, Nadi in the Western parts of India have been developed as the water management techniques to mitigate the drought over the period of time. Similarly, ***Khejri*** and ***Bare*** are the local plants, which are less water intensive crop	Rajasthan	Kumar, 2014
96 % of the farmers have ***adopted agro forestry*** as an adaptation strategy to climate change	North Kinangop, Kenya	Njenga et al, 2014
Farmers in Uttar Pradesh have started using ***PVC pipe***s to carry water to farms as a measure to save water	Uttar Pradesh, India	Tripathi and Mishra, 2017
Farmers in Ethiopia adapted to soil and water conservation practices i.e. ***tile drainage and cover crops***	Ethiopia	Belay, 2017
35.5 % of the farmers have adopted Agro-forestry, perennial plantation adopted to climate change	Benin	Fadina and Barjolle, 2018

ii. Animal Husbandry

The cooked Banana peels are used as the supplementary fodder feeds of the cow in Sirsi taluk of Uttara Kanada as the grass fodders have become scarce owing to climate change	Karnataka, India	Hegde, 2015
Farmers followed integration of crops with livestock as measure to cope with climate change	Ethiopia	Belay, 2017
A farmer from Pennsylvania adopted a new sheep breed "Katahdin" to reduce the risk of parasite attack owing to the increased warmer weather	USA	Waibel et al, 2018
Ola/Chappar is the ***indigenous dress of animal***s, which protects the animals from scorching heat of Rajasthan state	Rajasthan, India	Sarkar, 2015

iii. Indigenous Technical Knowledge (ITK)

Emergency ***fodder crop*** has been cultivated by the farmers of African Sahel traditionally to face the sever climatic condition	African Sahel, Africa	Nyong, 2007
In Jharkhand state, farmers follow ***Paira cropping system*** i.e Lathyrus seeds are broadcasted in standing rice under saturated conditions which helps in mitigating the changing climate; stone bunding and stone cum earthen bunding are used by Jharkhand farmers to save soil, water and nutrient	Jharkhand, India	Dey and Sarkar, 2011
Farmers in Himachal Pradesh have adopted ***Mind or Bidd*** cultivation to conserve the water from fluctuating climate, in the same way ***Apple paste*** has been prepared as a viable option to control the diseases like scale, canker and scab in the apple trees in the high altitude Himalayan regions; ***wood ash*** in vegetables like onion, garlic, brinjal, and tomato fields to control the pests such as pumpkin beetle, thrips, aphids and to supply nutrients; ***crush of Rambaan*** is also used by the farmers of Himachal Pradesh to manage rice pests like leaf folder, rice hispa as these pests incidences have increased due to climate change	Himachal Pradesh, India	Sarkar et al, 2015.
In Rajasthan, farmers use ***"Kanabandi"*** (a micro wind break of dead wood are built) as a management practice against the soil erosion as the recent climate change led to high temperature and low precipitation in Rajasthan, saline dust storm due to climate change has increased the Salinity problem of Rajasthan, yet the farmers use	Rajastha, India	Sarkar et al, 2015.

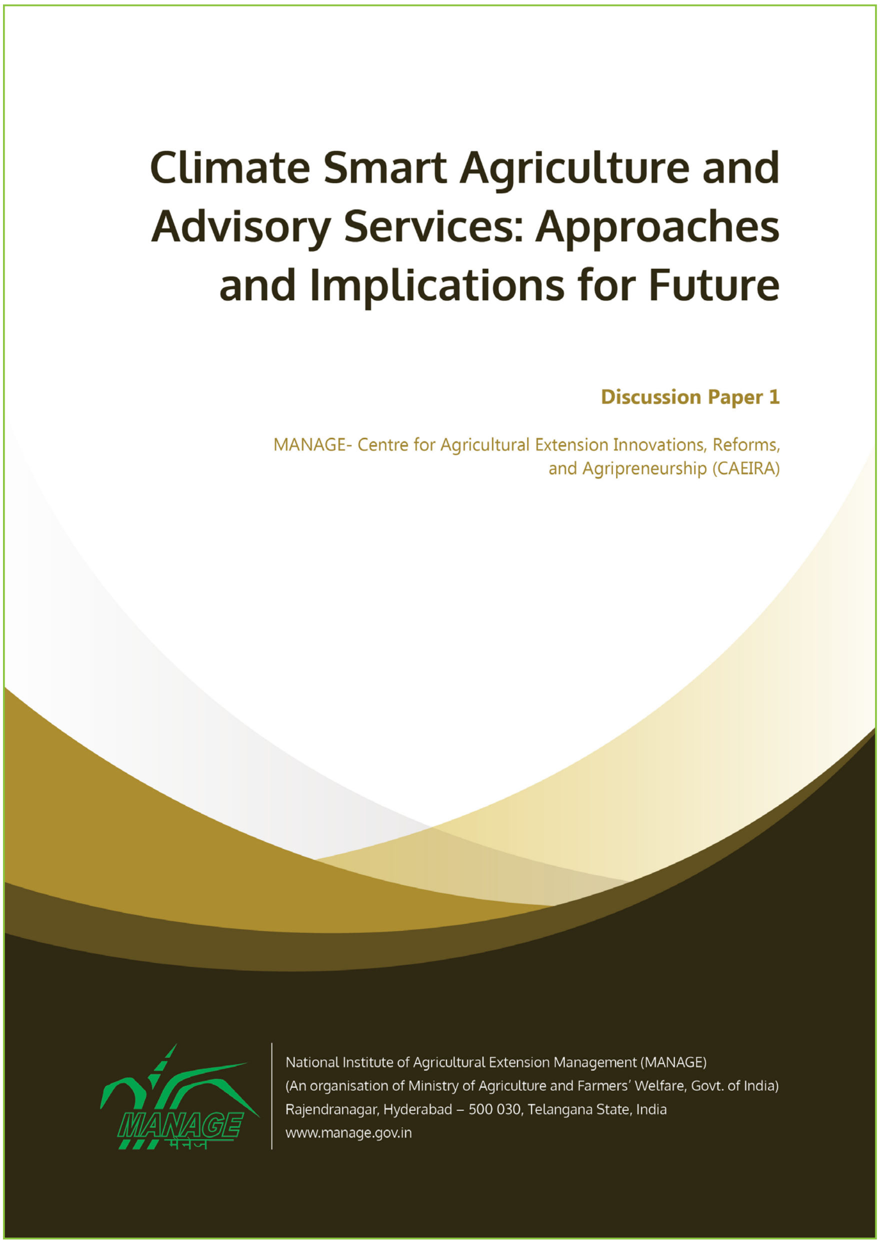
"Jhoor" mitigate the salinity problems; similarly, ***"Jhopa"*** practices to protect the tree sapling against the sun heat, winds and cold winters, mostly from Aandhi and Loo, these climate increased due to change in climatic condition. On the other hand, ***Khadin farming system*** is used to save water; and Kothi are used as the traditional storage godowns for fodder and grain respectively.		
Local rice variety ***Bao,*** which is an indigenous deep water/floating variety able to withstand the intermittent flash floods than hybrid rice. It is also tolerant to drought	Assam, India	Rahman, 2017
Tea growers of Assam have begun to practice ***planting of neem tress, fruit trees, berry trees burning of tobacco*** leaves as the measures to control increased new pests' incidence due to climate change. Besides, Tea growers now use the T-shaped stick borrowed from rice growers as a resting place for birds while praying on pests. Rice farmers of Assam use raw cow dung mixed with water/scattering the pumalo on the paddy fields and rearing of ducks nearby paddy field as these duck feed on Rice hispa pest.	Assam, India	Rahman, 2017
The fishermen have built the shallow ponds in the low-lying areas with tall embankments. Moreover, the r***aw cow dung and water*** is applied in the bottom of the ponds as sealant to prevent the leakage.	Assam, India	Rahman, 2017

Factors responsible for influencing farmers/general public toward mitigation and adaptation

a. What influenced		
Access to market and inputs such as different crop varieties, seeds and irrigation technologies	Developing countries	Feder et al, 1985
Higher/off farm income is found to have influenced the farmers in adoption of effective and expensive technologies provided these technologies responds to the climate change efficiently	Africa	Franzel, 1999
Experience is the key in adaptation of measures to climate change	Rural Kenya, Benin	Hassan and Nhemachena. 2008, Fadina and Barjolle, 2018
Larger family size adopts labour intensive adaptation measure	Rural Kenya	Nyangena, 2008

Access to technology (farm machinery) is the major factors in adaptation to climate change for African farmers	Africa	Hassan and Nhem-achena. 2008
Increased household size is the likely to influence the adaptation to climate change	-	Deressa et al, 2009 Ali and Erenstein, 2017
Higher non-farm income helps in adaptation to choose of planting trees and changing the time of planting trees as well as irrigation	Ethiopia, Benin	Deressa et al, 2009, Fadina and Barjolle, 2018
Normative, socio and cultural barriers have been an obstacle to the Dalits to switch over to other livelihood options	Western Nepal	Jones and Boyd, 2011
Institutional arrangement for land rights and land ownership has affected the adaptation to climate change	Benin, Africa	Yegbemey et al, 2013
Access to information on climate change and adaptation options have potential influence in adaptation to climate change	Semi-arid Eastern Cape Karoo, Africa	Muller and Shackleton, 2014
Extension services, technology transfer, capacity builing at local level, national level plays a role in adaptation to climate change; so, as value chain and economic incentives	Tamil Nadu, India, Pakistan	Dhanya and Ramachandran, 2015 and Vemeulen, Dinesh, 2016, Ali and Erenstein, 2017
Access to agricultural extension, credit and farm assets are vital in influencing farmers to adapt to climate change	Ethiopia, Ghana, Pakistan, Kenya, Rural Kenya, Pakistan	Deressa et al, 2016, Balew et al, 2014, Fosu et al, 2012, Ali and Erenstein, 2017, Njenga et al, 2014, Hassan and Nhemachena. 2008
Indigenous knowledge helps in adaptation measures to climate change in many ways	-	Vemeulen and Dinesh, 2016
b. Who influenced		
Non-Governmental organisation has played a crucial role in adaptation to climate change among farmers	Benin, Africa	Baudoin, 2014
Kaveta Village farmers have received 1 % of climate change information from NGO, 2 % of them from County Government of Kitui (CGoK)	Kenya	Mutunga, 2017

In Mikuyuni Village people have received 12 % of climate information from NGO and 3 % from County Government of Kitui (CGoK)	Kenya	Mutunga, 2017
23 and 52 % of the people of Kaveta and Mikuyuni villages have received climate information from media	Kenya	Mutunga, 2017



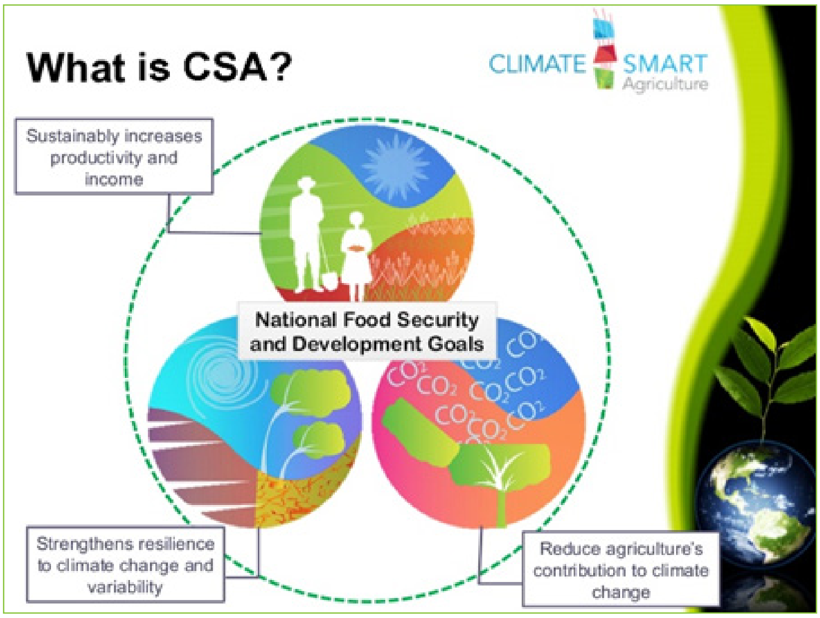
http://www.manage.gov.in/publications/discussion%20papers/MANAGE-Discussion%20Paper-1.pdf

What is Climate Smart Agriculture?

CSA is an approach for developing agricultural strategies to secure sustainable food security under climate change. CSA provides the means to help stakeholders from local to national and international levels identify agricultural strategies suitable to their local conditions. CSA is one of the 11 corporate areas for resource mobilization under the FAO's Strategic Objectives. It is in line with FAO's vision for Sustainable Food and Agriculture and supports FAO's goal to make agriculture, forestry and fisheries more productive and more sustainable". Food and Agricultural Organisation of the United Nations (FAO) which coined the term Climate Smart Agriculture (CSA), defines it as "agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces or removes GHGs (mitigation) where possible, and enhances achievement of national food security and development goals" (FAO, 2013).

The three pillars of CSA

Productivity: CSA aims to sustainably increase agricultural productivity and incomes from crops, livestock and fish, without having a negative impact on the environment. This, in turn, will raise food and nutritional security. A key concept related to raising productivity is sustainable intensification.



Source: Presentation by Irina Papuso and Jimly Faraby, Seminar on Climate Change and Risk Management, May 6, 2013.

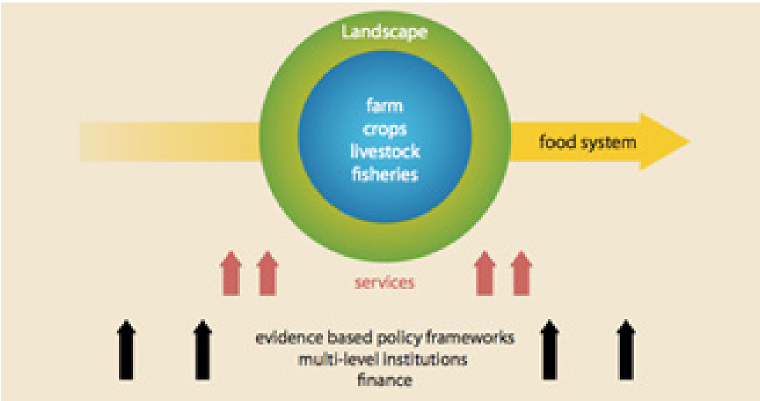
Adaptation: CSA aims to reduce the exposure of farmers to short-term risks, while also strengthening their resilience by building their capacity to adapt and prosper in the face of shocks and longer-term stresses. Particular attention is given to protecting the ecosystem services which ecosystems provide to farmers and others. These services are essential for maintaining productivity and our ability to adapt to climate changes.

Mitigation: Wherever and whenever possible, CSA should help to reduce and/or remove greenhouse gas (GHG) emissions. This implies that emissions from production of each calorie or kilo of food, fibre and fuel should be reduced; deforestation from agriculture should be avoided and manage soils and trees in ways that maximizes their potential to act as carbon sinks and absorb CO2 from the atmosphere.

Elements of CSA

Climate Smart Agriculture (CSA) may be defined as an approach for transforming and reorienting agricultural development under the new realities of climate change (Lipper et al., 2014). CSA is not a set of practices that can be universally applied, but rather an approach that involves different elements embedded in local contexts. CSA relates to actions both on-farm and beyond the farm, and incorporates technologies, policies, institutions, and investment. Different elements which can be integrated in climate smart agricultural approaches include:

- Management of farms, crops, livestock, aquaculture, and capture fisheries to manage resources better, produce more with less while increasing resilience.
- Ecosystem and landscape management to conserve ecosystem services that are key to increase resource efficiency and resilience at the same time.
- Services for farmers and land managers to enable them to implement the necessary changes.



Source: https://ccafs.cgiar.org/climate-smart-agriculture-0#.WnqMM-hublW

Why CSA?

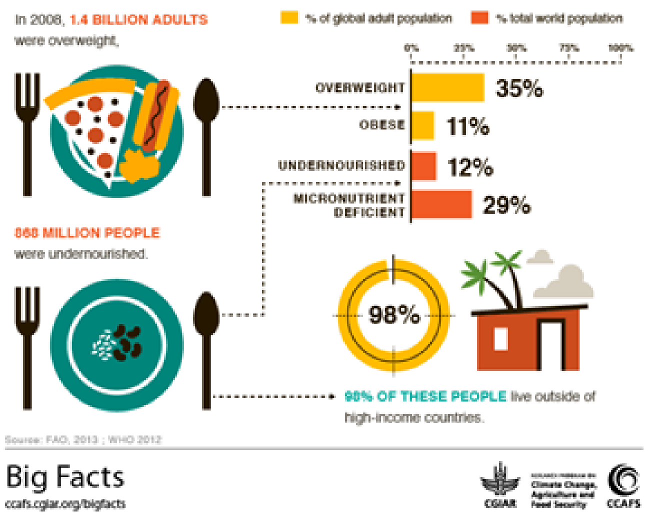
Climate change is emerging as a major threat on agriculture, food security, and livelihood of millions of people in many places of the world (IPCC, 2014). Climate change is already negatively impacting agricultural production globally and locally. FAO estimates that feeding the world population will require a 60 percent increase in total agricultural production by 2050 (FAO, 2015). With many of the resources needed for sustainable food security already stretched, the food security challenges are huge.

Climate risks to cropping, livestock, and fisheries are expected to increase in coming decades, particularly in low-income countries where adaptive capacity is weaker. Impacts on agriculture threaten both food security and agriculture's pivotal role in rural livelihoods and broad-based development. Also the agricultural sector, if emissions from land use change are also included, generates about one-quarter of global greenhouse gas emissions.

CSA approaches aims to identify and prioritize locally appropriate Climate Smart Agriculture technologies which will address a number of context-specific multi-dimensional challenges in agricultural systems.

1. CSA addresses food security, misdistribution and malnutrition

Global food consumption trends are changing drastically, for example, more than 1.4 billion adults are overweight and one third of all food produced is wasted (United Nations, 2015). If the current trends in consumption patterns and food waste continue, it is estimated we will require 60% more food production by 2050 (Alexandratos and Bruinsma, 2012). CSA helps to improve food security for the poor and marginalised groups while also reducing food waste globally (CCAFS, 2013).



2. CSA addresses the relationship between agriculture and poverty

It is estimated that about 75% of the world's poor live in rural areas, with agriculture being their most important income source (Lipper et al., 2014). As such, agriculture is uniquely placed to propel people out of poverty. Agricultural growth is often the most effective and equitable strategy for both reducing poverty and increasing food security (CCAFS and FAO, 2014).

3. CSA addresses the relation between climate change and agriculture

Agriculture sector is particularly vulnerable to climate change because different crops and animals thrive in different conditions. This makes agriculture highly dependent on consistent temperature ranges and water availability, which are exactly what climate change threatens to undermine. In addition, plant pests and diseases will likely increase in incidence and spread into new territories (Grist, 2015), bringing further challenges for agricultural productivity.

The relationship between agriculture and climate change is a two-way street: agriculture is not only affected by climate change but has a significant effect on it in return. Globally, agriculture, land-use change, and forestry are responsible for 19-29% of greenhouse gas (GHG) emissions. Within the least developed countries, this figure rises to 74% (Vermeulen et al., 2012; Funder et al., 2009).

If agricultural emissions are not reduced, agriculture will account for 70% of the total GHG emissions that can be released if temperature increases are to be limited to 2°C. For this reason, mitigation is one of the three pillars of Climate Smart Agriculture.

Climate Smart Villages

Climate Smart Agriculture (CSA) is proposed as a solution to transform and reorient agricultural systems to support food security under the new realities of climate change. Addressing the need for proven and effective CSA options, CCAFS has developed the Climate Smart Village (CSV) approach as a means to agricultural research for development (AR4D) in the context of climate change.

The approach of Climate Smart Villages is tailored, rather than one-size-fits-all. It seeks to fill knowledge gaps and stimulate scaling of CSA. The vision of the CSV AR4D approach includes i) Multi-stakeholder learning platforms; ii) Participatory test-beds for generating greater evidence of CSA effectiveness; and iii) Cornerstones to draw out scaling lessons for policy makers from local to global levels.

The CSV approach is founded on the principles of participatory action research for grounding research on appropriate and location/context-specific enabling conditions, generating greater evidence of CSA effectiveness in a real-life setting and facilitating co-development of scaling mechanisms towards landscapes, sub-national and national levels (CCAFS, 2016a).

Methodology adopted to form CSV

The location of a Climate-Smart Village is selected based on its climate risk profile and the willingness of farmers and local governments to participate in the project. Researchers conduct a baseline survey to capture the current socio-economic conditions and analyse resource availability and average production and income among other indicators. This enables an impact assessment after a period of time to gauge the benefits of the interventions. Stakeholders convene to prioritize which interventions they will take up that are best suited to their local conditions. This is done through a choice experiment that analyses their preference and willingness to pay for technologies. Disseminating information on Climate Smart Agriculture practices and outcomes is an important part of the capacity building process. Farmers are encouraged to record their testimonials and feedback at regular intervals and share it with researchers and the community (Schubert and Parthasarathy, 2013).

CCAFS started piloting the CSV approach in 2012 in Africa (Burkina Faso, Ethiopia, Ghana, Kenya, Mali, Niger, Senegal, Tanzania and Uganda), and South Asia (Bangladesh, India and Nepal) and then extended in 2014 to Latin America (Colombia, Guatemala, Honduras and Nicaragua), and Southeast Asia (Cambodia, Laos, Philippines and Vietnam). CCAFS and its partners currently facilitate AR4D in about 36 CSV sites (CCAFS, 2016a).

Climate-Smart Services by CGIAR

In addition to farm practices, farmers in climate-smart villages are also testing climate-smart services, such as tailored weather forecasts to plan planting, harvesting and other activities on the farm. Advisories and weather forecasts are being delivered by mobile phones, and phones are also being used to enable farmers to buy index-based insurance that gives them a measure of protection in the event of extreme weather (CCFAS, 2016c).

Approaches of ICRISAT in building climate smart villages

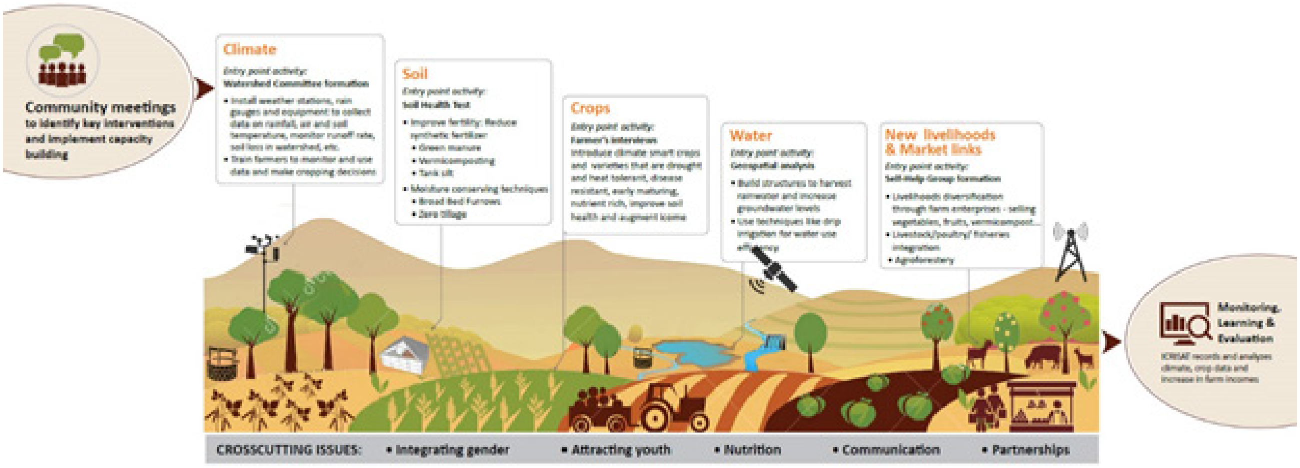
ICRISAT with varied partners has developed climate resilient dryland crops and a pool of climate-smart technologies that are used in all of its climate-smart project interventions. The approaches focused on equipping farmers to use climate-smart scientific interventions and innovations, use climate information for cropping decisions, diversify livelihoods, link to markets, make agriculture profitable, rehabilitate and restore their environment and influence policy makers. The detailed description of each approach is discussed below (ICRISAT, 2015).

Source: https://i.pinimg.com/474x/a9/e8/36/a9e83698b29fc520c4b5ca3712174277--weather-and-climate-climate-change.jpg

1. The watershed management approach

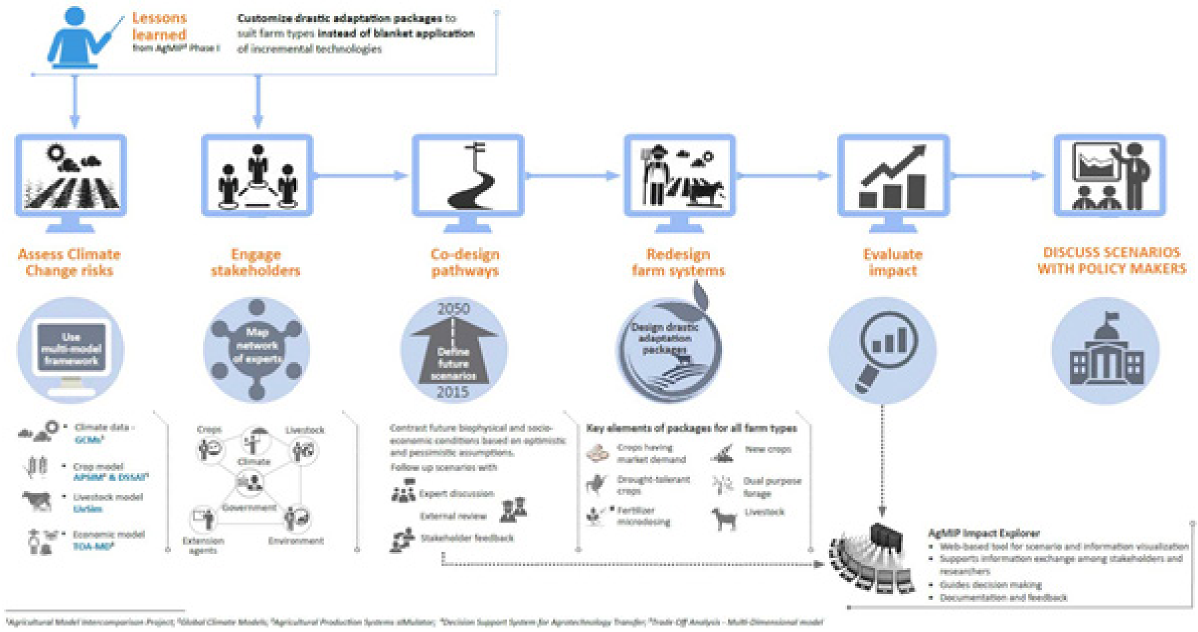
ICRISAT along with the Karnataka State Department of Agriculture, District watershed development, NGOs and the local community has undertaken watershed interventions in four villages of Bellary district in the mining belt of Karnataka covering 7,000 ha. This approach focuses on rehabilitating agro ecosystems and deploys a pool of climate-smart agricultural practices developed by ICRISAT which have resulted in increasing crop yields and incomes of farmers. Interventions ranged from monitoring the weather, mapping soil health, and choosing climate resilient varieties to water harvesting and improved livelihoods through the watershed approach.

Water harvesting structures captured an additional 18,500 cubic meters with a gross conservation of 25,000 cubic meters rainwater during the rainy season. Groundwater level also increased by 1.5-2.0 meters. With soil test based fertilizer application the overuse of fertilizers was reduced, which meant lower cost of cultivation by 10-15%. The yield of groundnut and maize increased by 19% and 27%, respectively. And many new livelihood options led to an increase in the income of households by US$22 – US$37 per month. This approach is gaining momentum in India is also favored by JSW Group of companies for their corporate social responsibility activities.



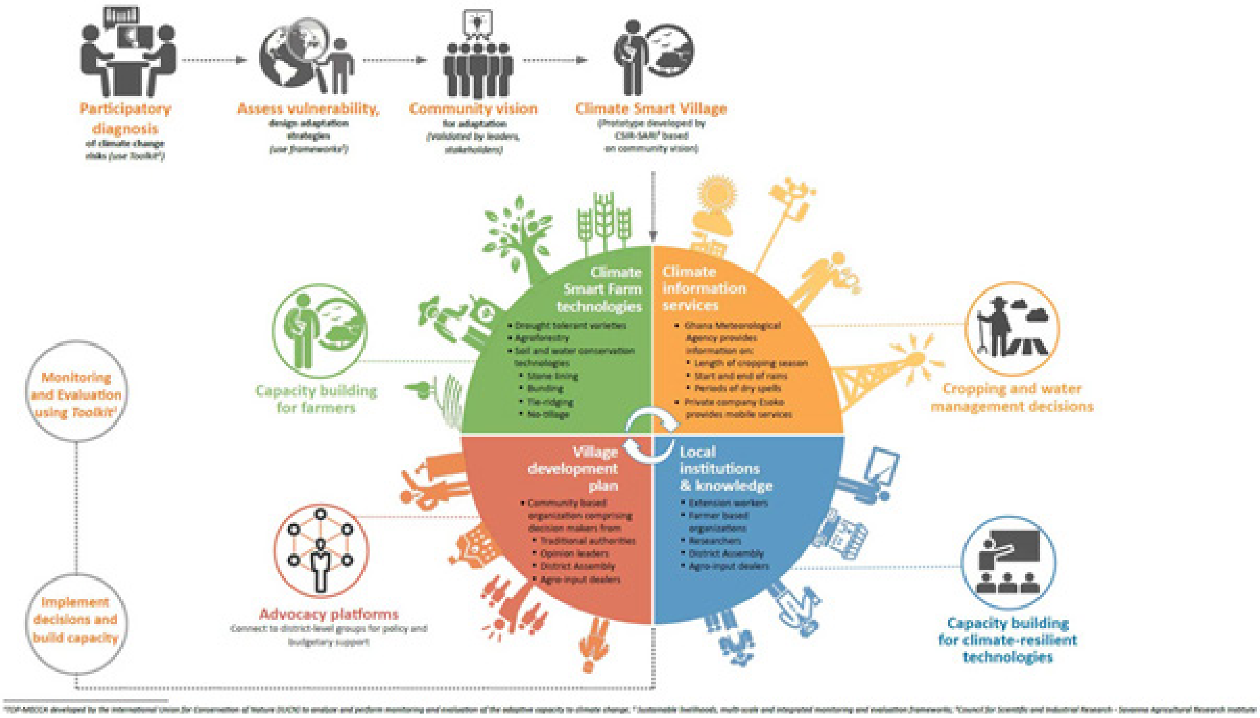
2. The futuristic multi-model approach

Nkayi district of Zimbabwe was hit by two consecutive droughts and farmers are reeling under the impact of unpredictable climate. Using a multi-model framework for climate, crop, livestock and socio-economic simulation, customized climate change adaptation packages were developed for farmers in Nkayi, Zimbabwe. This model uses computer-simulated scenarios which helps policy makers in Zimbabwe to make crucial decision to support farmers based on the climate scenario. The result was renewed support for promoting dryland cereals – sorghum and millet and greater support for groundnut value chains.



3. The digital technologies approach

In Jirapa district of Ghana had long spells of drought that leads to partial or total crop failures. The region has extremely challenging conditions for farmers with high temperatures, erratic rainfall and eroded soils resulting in lower crop yields. The development of the Climate Smart Village (CSV) starts with participatory diagnosis using a Toolkit for Planning, Monitoring and Evaluation on Climate Change Adaptive capacities (TOP-MECCA) developed by the International Union for Conservation of Nature (IUCN) to analyze and perform monitoring and evaluation of the adaptive capacity to climate change (Somda et al., 2011). This approach has helped farmers from the Doggoh community in remote Ghana to adopt Climate smart agricultural practices and take up agroforestry in a big way. Farmers who had never used a phone are now using mobiles for climate information to make cropping decisions. About 90% of the farmers find the weather alerts useful and 64% of them also make use of the helpline when needed.

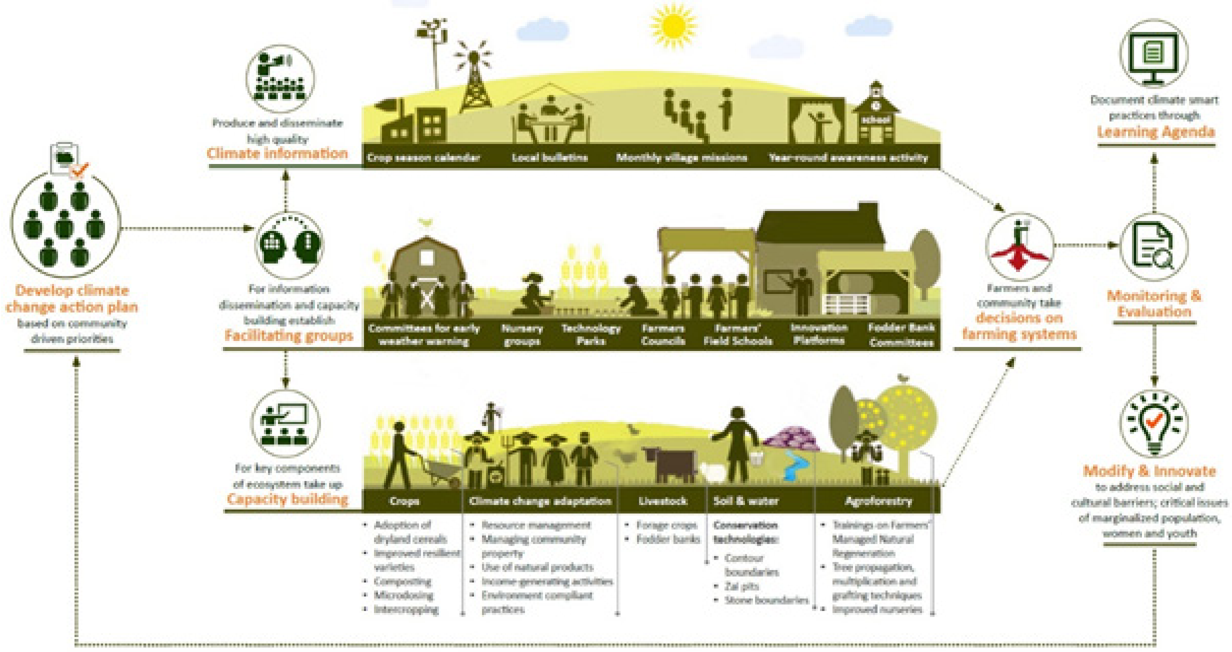


4. The metrological advisory and farm systems approach

Mopti region in Mali is characterized by frequent recurrence of dry years and prolonged drought. Inter-annual rainfall variability is very high and the region is exposed to both flooding and drought. Climate change predictions for 2025 point at an average temperature increase of 2.71°C to 4.51°C. Rainfall is predicted to decrease by 11%. Crop yields may decrease by 5.5% and forage yields may fall by 20%.

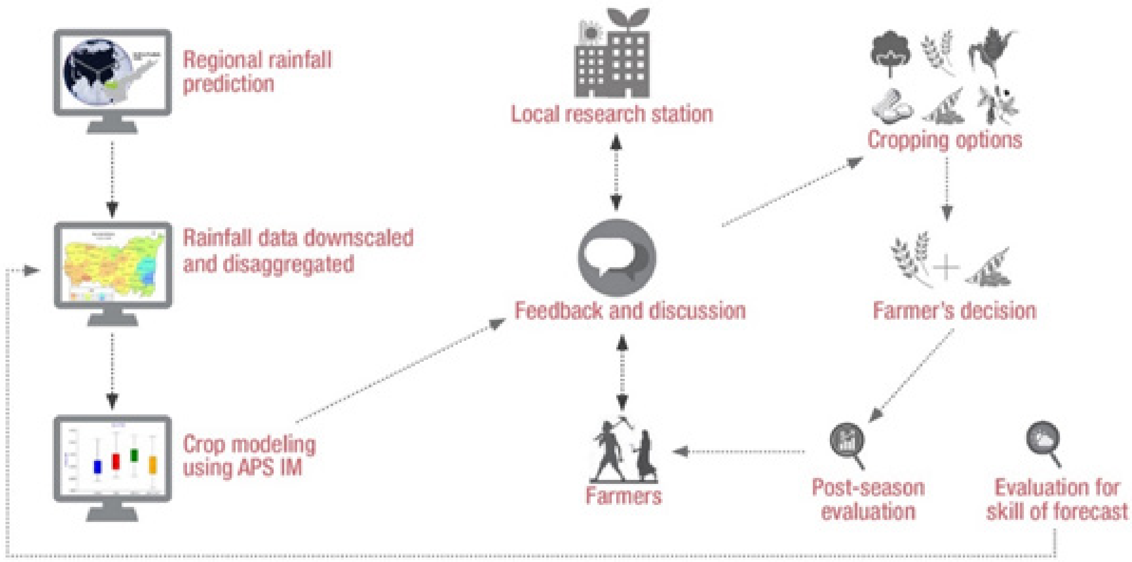
Innovative climate-resilient technologies developed specifically for Mopti, Mali, were implemented in 458 ha to demonstrate that climate change adaptation by using eco-friendly methods and climate information. Close to 76,000 women and 94,000 men representing all stakeholders in the value chain reported using climate information in their decision making.

The interventions were establishment of groups such as Groups for Local Meteorological Assistance (GLAM), Municipal Rural Meteorological Assistance Groups (GCAM) and committees for early warning such as Local Early Warning Committees (CLAP). Farmer Field Schools (FFSs) provided training on resilient technologies and other innovative practices specific to the village. Fodder bank management committees ensured growing high-protein forage. Capacity building programmes were conducted on the areas such as crop and livestock, agroforestry, soil and water conservation techniques.



5. The climate and crop modelling approach

In view of the recurrent droughts (twice every five years), in Kurnool district of Andhra Pradesh, crop advisories using climate and crop simulation modeling were developed using the approach to minimize farmers' risk in years with less rainfall. Farmers who followed the cropping advisory earned 20% more than others farmers. The success of this pilot project has led to its expansion in other villages of Andhra Pradesh and the neighboring state of Karnataka.



Source: http://annualreport2015.icrisat.org

Climate Change Knowledge Network in Indian Agriculture (CCKN-IA)

The project "Climate Change Knowledge Network in Indian Agriculture" (CCKN-IA) is jopintly implemented by National Institute of Agricultural Extension management (MANAGE) with technical cooperation from German Development Cooperation (GIZ). GIZ implements sustainable development through international cooperation on behalf of Germany and other partners. The project is also supported by the GOPA consultants to ensure its successful implementation and achieving desired results. The objective of the CCKN-IA programme is to develop a robust network exchange systems to effectively share knowledge across the gamut of stakeholders in three selected Indian states namely, Maharashtra, Jharkhand, and Odisha on a pilot basis. This is to ensure improved access to updated, timely, authentic, and situation specific information that enables the farmers, extension service providers and policy planners get better equipped to adapt to climate change. Such collaborative efforts contributes towards innovative ways to meet the farmers' needs in real time and providing a multi-modal two-way exchange processes. CCKN-IA is geared at increasing the efficiency and effectiveness of public and private resources and improving the service delivery of both (http://cckn-ia.org, 2018).

Mitigation of Climate Change in Agriculture (MICCA) programme

The Mitigation of Climate Change in Agriculture (MICCA) programme strengthens FAO's longstanding work to address climate change in the agriculture, forestry and fisheries sectors and supports countries participating in the climate change negotiation processes within the United Nations Framework Convention on Climate Change (FAO, 2018). The MICCA programme generates technical knowledge, working on the ground and with partners to:

- Monitor and assess greenhouse gas (GHG) emissions and the mitigation potential in agriculture;
- Develop the capacity of stakeholders working on national GHG inventories and farmers using CSA practices;
- Carry out life cycle assessments to guide decision making;
- Give guidance on climate change mitigation & adaptation options, including for peatlands and organic soils;
- Mainstream gender in CSA; facilitate online communities of practice; and run online learning events.

National Innovations on Climate Resilient Agriculture (NICRA) in India

National Innovations on Climate Resilient Agriculture (NICRA) is a network project of the Indian Council of Agricultural Research (ICAR) launched on 2nd February, 2011. The project aims to enhance resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration. The research on adaptation and mitigation covers crops, livestock, fisheries and natural resource management. The project consists of four components viz. Strategic Research, Technology Demonstration, Capacity Building and Sponsored/Competitive Grants. The objectives of the project were i) 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, ii) to demonstrate site specific technology packages on farmers' fields for adapting to current climate risks and to enhance the capacity building of scientists and other stakeholders in climate resilient agricultural research and its application (NICRA, 2016). The impact of NICRA were establishment of 150 Climate Resilient

Villages; establishment of custom hiring centres for farm machinery; conduct of demonstration in 6803 farmers' fields covering 3431 ha; 722 training programs were organized covering 27,887 farmers; smart farmer certificates were awarded to 4,605 NICRA farmers and Identified 27 climate resilient practices for up-scaling under NMSA (Rao, n.d).

USDA Building Blocks for Climate Smart Agriculture and Forestry

U.S. Department of Agriculture's (USDA) Building Blocks for Climate Smart Agriculture and Forestry was launched on April 23, 2015. This plan is designed to help farmers, ranchers, forestland owners, and rural communities respond to climate change and consists of the following 10 "building blocks," which span a range of technologies and practices to reduce greenhouse gas (GHG) emissions, increase carbon storage, and generate clean renewable energy (USDA, 2016).

Building Block Goals and Key Actions

Building Block	**Key Actions (2016-2018)**
Soil Health	• Develop and implement a Soil Health Monitoring and Enhancement Network. • Develop advanced soil health training course and complementary webinar series to train trainers, as well as certification requirements for soil health management planners. • Provide advanced soil health training for more than 2,000 field, area, and state technical staff to build capacity for improved technical assistance to stimulate adoption. • Continue to leverage partnerships to develop standardized comprehensive soil health assessment availability and economic data. • Review and update Conservation Practice Standards related to soil health management systems (SHMS). • Continue to invest in research, education, and extension on practices that promote soil health and reduce GHG emissions from cropland.
Nitrogen Stewardship	• NRCS staff develop nutrient management plans for producers on 13 million acres. • Provide additional Technical Service Provider support to develop nutrient management plans on 6.5 million acres. • Partner with agri-businesses to provide assistance to producers for nutrient management on 1 million acres. • Develop a Memorandum of Understanding among NRCS and several agricultural industry organizations and conservation groups to address the resource issues facing farmers and ranchers, including climate change and GHG emissions. • Develop, publish, and distribute literature on nitrogen management to improve nutrient use efficiency, reduce emissions, and improve water quality. • Support the development of extension materials on nitrogen fertilizer and manure management.

Livestock Partnerships	• Recruit and train the additional NRCS and RBS technical professionals and Technical Service Providers needed to provide direct technical assistance to producers to install and operate anaerobic digesters and the associated electrical generation equipment, covers with flares, solid separators, and other manure management technologies that reduce GHG emissions. • Through REAP and EQIP, explore mechanisms to prioritize anaerobic digesters and the appropriate associated electrical generation technology, covers with flares, solid separators, and other manure management technologies that reduce GHG emissions.
Conservation of Sensitive Lands	• Enroll 120,000 additional high-carbon acres in wetland and riparian buffer practices. • Provide technical assistance funding for States to hire additional foresters. • Provide outreach funds for State foresters.
Grazing and Pasture Lands	• Identify regions (Major Land Resource Areas) with the greatest potential for carbon sequestration and methane emission reduction via Prescribed Grazing. • Adjust NRCS State Office priorities for providing technical assistance to grazing land managers in high priority regions. • Implement conservation field trials for organic waste application in California. • Initiate research and development effort to improve enteric fermentation/ forage intake estimation model. • Enroll an additional 2 million acres into the Prescribed Grazing, Range Planting, and Forage and Biomass Planting Practice Standards.
Private Forest Growth and Retention	• Enroll an additional 275,000 acres of private forestland in the Forest Legacy Program and Community Forest Program.
Stewardship of Federal Forests	• Reforest 96,000 acres of post-disturbance National Forest System (NFS) lands. • Treat 8.1 million acres to sustain or restore watershed function and resilience. • Treat 5.1 million acres of high-priority fuels in the Wildland Urban Interface on NFS lands.
Promotion of Wood Products	• Provide technical assistance for more than 1,500 wood building projects. • Organize and host a national conference on mass timber

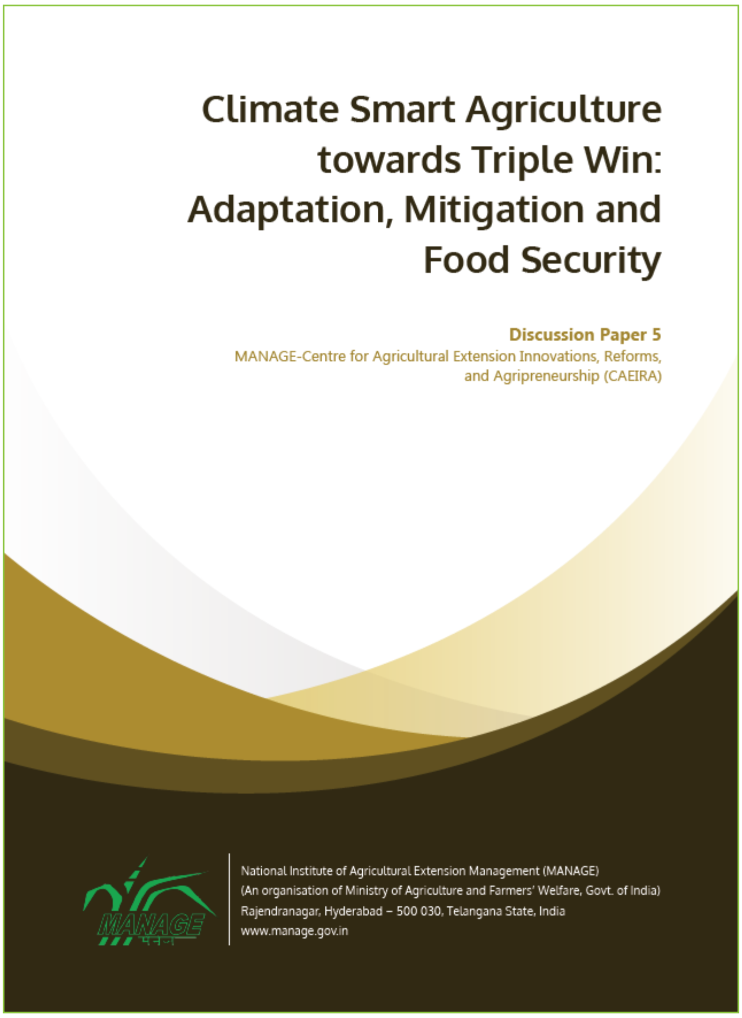
(Source: USDA. (2016). Building Blocks for Climate Smart Agriculture and Forestry: Implementation plan progress report)

Cornell Institute for Climate Smart Solutions

The Cornell Institute for Climate Smart Solutions (CICSS) was established in September 2013 in New York by the Cornell University Agriculture Experiment Station. The mission of the institute is to facilitate research related to climate science and policy, environmental and agricultural systems, food security and social resiliency; to conduct education and outreach to stakeholders, decision makers and the public to increase sustainability and resiliency to climate change and to build partnerships and engage stakeholders to share information and develop climate change solutions.

CICSS has established the first Climate Smart Farming (CSF) Extension Team in the nation. Spanning New York State, the CSF team provides climate information related to economic development, dairy, grapes, small fruits, vegetables, integrated pest management, field crops, and soil health issues and answering farmers' questions about climate variability and farm management. This innovative approach to extension programming can serve as a model for climate change extension efforts nationwide (CICSS, n.d.).

Cornell Climate Smart Farming (CSF) Program was established by the Cornell Institute for Climate Smart Solutions (CICSS) in 2015. The Program is specifically designed with profitability, mitigation, and adaption in mind to help farmers in New York and the Northeast: (1) sustainably increase agricultural productivity, (2) reduce greenhouse gas emissions and increase energy efficiency, and (3) build resilience to extreme weather and climate change/variability through best mitigation and adaptation practices (Lambert et.al, 2017).



http://www.manage.gov.in/publications/discussion%20papers/MANAGE-Discussion%20Paper-5.pdf

Knowledge Management in CSA

Network for Information on Climate (Ex) Change (NICE+) Android Application

Network for Information on Climate (Ex) Change (NICE+) facilitates gathering, validating and disseminating knowledge for improving farmers' resilience towards the impacts of climate change. This application is developed under the project Climate Change Knowledge Network in India Agriculture (CCKN-IA) jointly implemented by GIZ (German development cooperation) and MANAGE, an organisation under Ministry of Agriculture and Farmers Welfare, Government of India. NICE+ is niche application developed for collecting, validating and disseminating information on climate change adaptation in the agriculture sector in India. NICE+ is implemented on a pilot basis in three States of India namely Maharashtra, Jharkhand, and Odisha. This app works only in combination with a specific web solution developed for this project and is only accessible for registered users. Relevant information is collected in a decentralised process, through this app and the backend system. The system is completely open source based and can be accessed through web- and an android based mobile application (https://play.google.com, 2018).

NICE allows existing multiple knowledge stakeholders from domains like meteorology, agriculture science, extension systems and others to share and adapt knowledge across multiple subject domains, to address local needs. The system is iterative and allows multimodal approach, enabling two-way communication to link farmers' needs and knowledge providers, on a real time basis. The tablet application of NICE capacitates extension cadres as final mile technology interfaces. Source of information is from various government organizations and in various formats. Information or expert advices need to be collated, validated and disseminated as text messages (SMS), voice SMS, videos, fact sheets & posters to farmers for adoption to the impacts of Climate Change. The system is completely based on open source technologies and can be accessed through a web- and an android based mobile application. So far, over 100 experts from domains like agronomy, livestock management, soil and water conservation, and others have been identified and trained to use the NICE platform to develop and disseminate localized advisories to farmers. The farmers and extension agents provide the localized advisory needs. The project is covering over 22,000 farmers across these 3 states of India. Over 100 identified and trained extension agents use the tablets to not only provide advisories to farmers but also collect feedback and queries from farmers. CCKN-IA is also training and handholding local extension agents, to capacitate them as local advisors on pest and disease management (http://cckn-ia.org, 2018).

Southern African Agricultural Information and Knowledge System (SAAIKS)

The Center for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA) is a sub-regional organization which was launched in July 2011 by the Southern African Development Community (SADC) member states to coordinate agricultural research and development in the Southern African sub-region. CCARDESA realized that agricultural information sharing was lacking within the Southern African Region and initiated the Southern African Agricultural Information and Knowledge System (SAAIKS). SAAIKS is an Information Communication and Knowledge Management (ICKM) system for sharing agricultural information across the region was embarked upon with support from CTA to incapacitate CCARDESA to be a hub for agricultural research, extension, and news information in various digital formats for the region. The objectives of SAAIKS were sharing agricultural information and knowledge among member states and beyond; development of agricultural database and resource information and sharing best practices for development and or adoption within the region.

CTA supported the building of a system and content for two disciplines, namely, underutilized crops and Climate Smart Agriculture and climate change adaptation. The selection of topics are very important for empowering stakeholders especially the vulnerable groups which predominantly include women and youth to building their resilience and adaptation to climate change which is negatively affecting the SADC region. This initiative aligns with a GIZ funded programme on adaptation to climate change in rural areas in SADC (ACCRA) hosted by CCARDESA whose key focus is on information dissemination. On the other hand, CCARDESA has been compiling information on under-utilized crops which are useful as a source of food and vital nutrients to many resource-poor households across the region. Availing this information through this platform would be useful to stakeholders (CCARDESA, 2018).

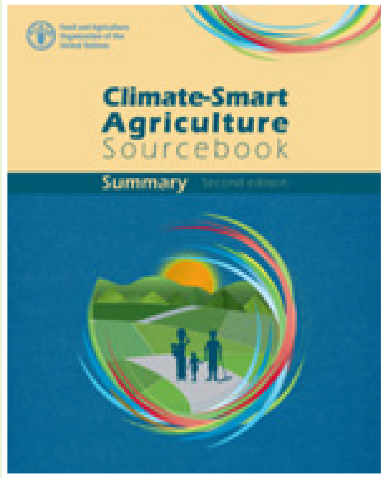
Climate Change Knowledge Management in Kenya

Four stage knowledge management model of Kenya were generation and gathering, Organisation, Storage and Dissemination. Agencies involved in climate change knowledge creation in Kenya include government, research and academic institutions, more than 300 civil society organisations and private sector companies. During the development of the Climate Change Knowledge Management System Prototype, an exercise to scope existing institutions involved in climate change work revealed that most of them lack a standardised method of organizing their knowledge. Various institutions have developed basic data bases, libraries and websites where they store the climate change knowledge they generate. Most institutions however lack electronic-based centralised systems for knowledge management. Such knowledge is mainly accessible through physical copies mostly placed in in-house libraries or stored as "hard copy" publications. There is no optimal sharing of climate change information and knowledge across government, private sector, CSOs, academic, research institutions and individual researchers. A few organisations are, however, starting to share their knowledge but in a small scale (Source: NCCAP, 2012).

Publications on Climate Smart Agriculture

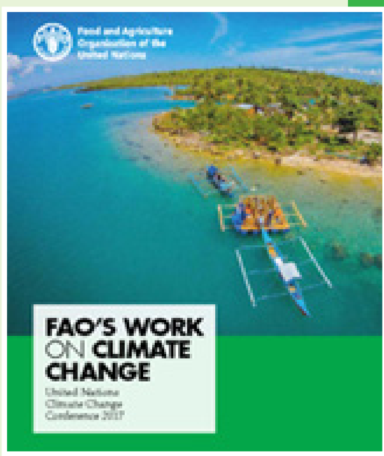
About the publication: The source book elaborates the concept of CSA and demonstrates its potential, as well as limitations. It aims to help decision makers at a number of levels to understand the different options that are available for planning, policies and investments and the practices that are suitable for making different agricultural sectors, landscapes and food systems more climate-smart. This source book has three main sections, namely, 'the case for climate smart agriculture', 'Improved Technologies and Approaches for Sustainable Farm Management' and "Enabling frameworks". The sourcebook indicates some of the necessary ingredients required to achieve a climate-smart approach to the agricultural sectors, including existing options and barriers.

Source: www.fao.org3a-i3325e.pdf



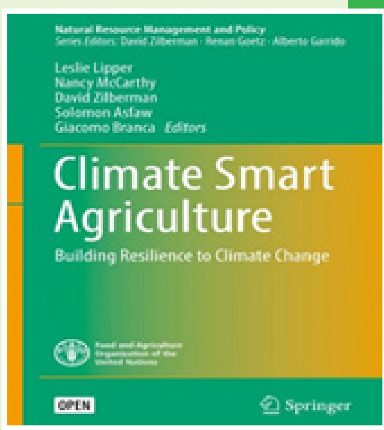
About the publication: The revised digital CSA Sourcebook contains updated versions of the original 18 modules and includes five new modules, viz, Climate change, adaptation & mitigation; Integrated production systems; Supporting rural producers with knowledge; The role of gender and a guide to evidence based implementation at the country level. CSA Sourcebook will be able to guide policy makers, programme managers, sectoral experts, academics, extension agents, and development practitioners in their efforts to make all the agricultural sectors more climate-smart.

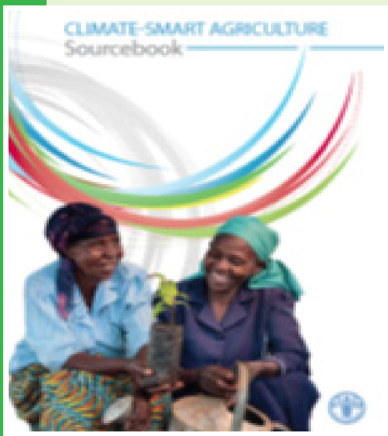
Source: www.fao.org/climate-smart-agriculture-sourcebook



About the publication: This is open-access book, co-published with Springer, provides tested good practices and innovative approaches for promoting CSA systems in support of food security at country level. The book is divided into three sections. The first section provides conceptual framing of the CSA concept; the second section is devoted to a set of case studies and the final section addresses policy issues related to climate change.

Source: https://link.springer.com/content/pdf/10.1007%2F978 -3-319-61194-5.pdf





About the publication: This publication was launched at Conference of the Parties (COP23) in Bonn, 2017. It includes a synthesis of the support provided by FAO to face the impacts of climate change. It also brings together the most recent and relevant knowledge, tools and methodologies FAO can offer countries to report no their greenhouse gas emissions from the agriculture, livestock and forestry sectors.

Source: www.fao.org/3/a-i8037e.pdf

About the publication: The purpose of the journal is to provide a platform to exchange ideas among those working in different disciplines related to climate variations. The journal also plants to create an interdisciplinary forum for discussion of evidence of climate change, its causes, its natural resource impacts and its human impacts. The journal will also explore technological, policy, economy, strategic and social responses to climate change. It will be peer-reviewed, supported by rigorous processes of criterion-referenced article ranking and qualitative commentary, ensuring that only standard accepted quality work of the greatest substance and highest significance is published.

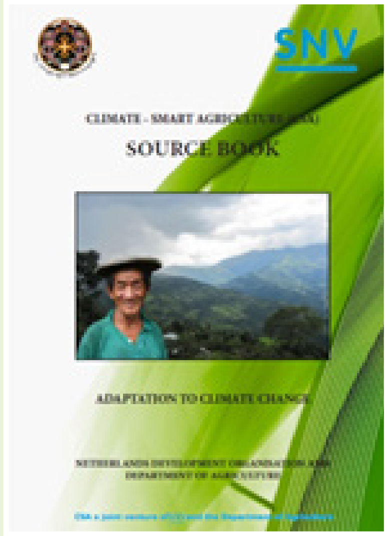
Source: www.iospress.nl/

About the publication: Joto Afrika is a series of printed briefings and online resources about adapting to climate change in sub- Saharan Africa. The series helps people understand the issues, constrains and opportunities that poor people face in adapting to climate change and escaping poverty. The series are produced in both English and French.

Source: www.alin.or.ke/Joto%20Afrika

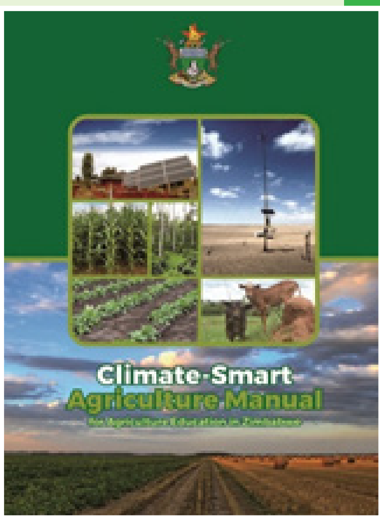
About the publication: The CSA Source Book was published by Netherlands Development Organisation and Department of Agriculture, Bhutan. The various initiatives and experiences of SNV on Climate-Smart Agriculture since 2013 undertaken in collaboration with the MoAF are comprehensively captured in this Source Book, which is expected to serve as an immediate reference for extension personals. CSA approach is new and the overall awareness and understanding of the CSA among the Bhutanese stakeholders is relatively poor. This source book provides a simple and a quick reference on the principles and approaches of CSA for different stakeholders at all levels.

Source: www.snv.org/public/cms/sites/default/files/explore/download/csa_bhutan_source_book_final.pdf



About the publication: Climate-Smart Agriculture Manual for Agriculture Education in Zimbabwe was published by Climate Technology Centre and Network, Denmark in 2017. This manual comprises of 12 chapters under three sections which contributes for further integration of a climate-smart approach in agricultural education and that future Zimbabwean extension workers, agriculture entrepreneurs and smallholder farmers will be better equipped to increase productivity and incomes, build resilience to climate change, reduce greenhouse gas emissions where possible, and ultimately, enhance the achievement of Zimbabwe's national food security and development goals.

Source: https://www.ctc-n.org/system/files/dossier/3b/climate-smart_agriculture_manual_final.pdf



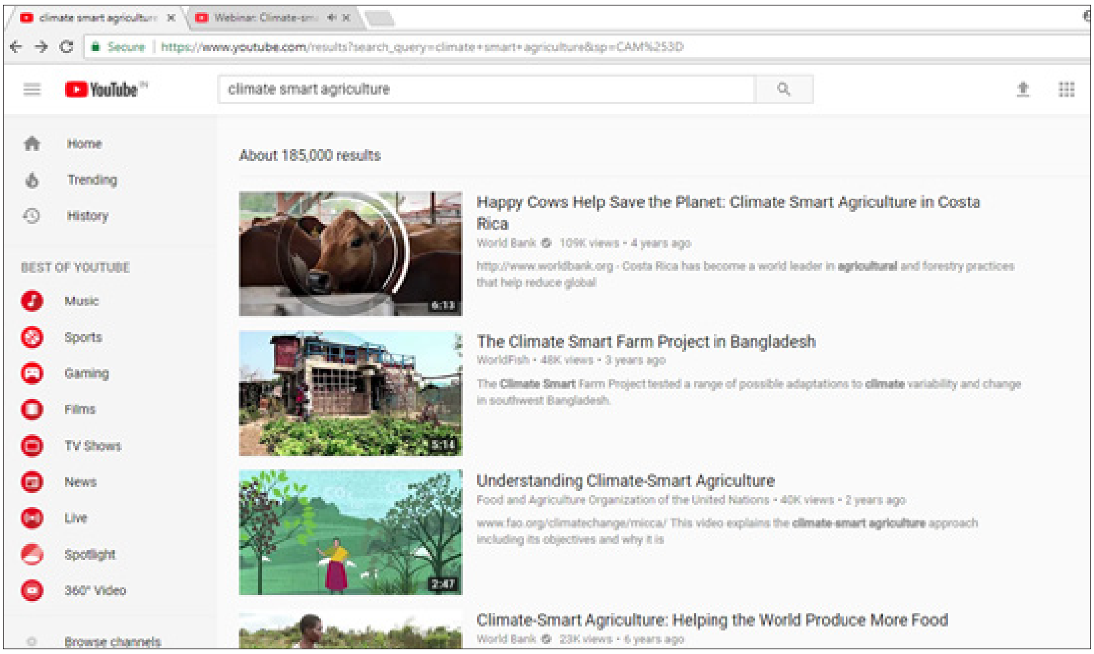
Website on CSA

FAO launches new Climate-Smart Agriculture web platform

First of its kind FAO launches website for Climate Smart Agriculture on November, 2017. FAO is implementing a series of global programmes that are successfully supporting countries to develop and implement the policy frameworks and institutional arrangements needed to transform policy and create an enabling environment for agricultural development under climate change (www.fao.org, 2017).

You Tube

You Tube, a video sharing platform, is the third most visited website in the world. There are around two lakh videos available on Climate Smart Agriculture. Most of the videos are produced by international organisations like Food and Agriculture Organisation, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) and World Bank etc and few are by NGOs who work for CSA. These videos explain the climate-smart agriculture approach including its objectives and why it is needed. The average duration of videos ranges from 5 to 15 minutes.



ICTs in CSA

Use of ICT for agro advisory services in a climate smart village in Nepal

Climate information services can be an important tool in helping farmers adapt to the impacts of climate variability and change. Delivery of vital weather and market information directly to smallholder farmers enables them to make on-farm decisions against adverse climatic conditions and reduce losses due to negative impact of climate change by linking scientific and extension expert knowledge to rural farmers. Climate Change, Agriculture and Food Security (CCAFS) in Nepal, in partnership with the Local Initiatives for Biodiversity, Research and Development (LI-BIRD) has collaborated with SMILES, an ICT provider to offer mobile and web based agro advisory services in Dang and Nawalparasi districts. Farmers who have subscribed for the services receive messages for market price of vegetables twice a week, and for weather-related information three times a week, through a push system. They are also trained to access detailed information on market price through a pull system. Group discussions with farmers revealed greater usefulness of market related information compared to climate.

This ICT services in the selected CSVs, initiated in March 2016, have a total subscription of 87 farmers (39% female) in two districts. There appears to be a growing demand to use these services, with many farmers expressing their interest and willingness to pay for it. CSV approach of climate change adaptation in farm communities in Nepal is aiming to make linkage of farmers to the government's ICT services (CCAFS, 2016b).

e-Arik – An initiative in Arunachal Pradesh to disseminate CSA technologies

e-Arik (e-agriculture) was an ICT-based project initiated in 2007 in Arunachal Pradesh, India, aimed to disseminate 'Climate-smart agricultural practices' and to achieve food security. Climate-smart farm practices were seen as those that were sustainable, low input and reliant on organic technologies; and focus was on paddy and Khasi mandarin oranges crops of the project area. The e-Arik project established a 'Village Knowledge Centre' with computer, internet link, printer, scanner, phone and TV at Yagrung village. Project facilitators were appointed at the centre to help farmers' access ICT-based agricultural information. A project portal was also created, providing information on crop cultivation and other agricultural practices, baseline information from relevant agriculture and rural developmental departments of government, specific information on government schemes such as farmers' welfare programmes and day-to-day market information and weather forecasts. Farmers could obtain information directly from the portal, off line CDs or via the facilitator intermediaries to access ICT-based information or to engage in remote consultation with other agricultural experts.

The project was successful in demonstrating application of ICTs in promoting Climate Smart Agriculture practices, new approaches to farming that require few external inputs and which are organic. For them, climate is an important issue and they recognise signs of climate change. However, their overriding priority and the main aspect that will contribute to the resilience in the face of climate change is increased incomes (Saravanan, 2011).

Participatory Integrated Climate Services for Agriculture (PICSA) approach in Africa

This approach aims to facilitate farmers to make informed decisions based on accurate, location specific, climate and weather information; locally relevant crop, livestock and livelihood options; and with the use of participatory tools to aid their decision making. The PICSA approach is divided into twelve steps to be carried out with groups of farmers. Due to the location specific nature of PICSA there are a number of preparatory activities that need to be completed before field staff are trained in the approach. During the first year of the Rwanda Climate Services for Agriculture project, funded by the United States Agency for International Development (USAID) and implemented by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), the PICSA approach has been implemented in four districts. The information provided within the project is locality specific and tailored to farmers' needs and written in the local language to enhance farmers' understanding. The information includes parameters such as the start and end of the rains, length of the growing season, total seasonal rainfall amount, longest dry spell within a cropping season, and short-term and long-term forecast. The farmer promoters were trained in advance and given printed copies of the information to be shared with famers. Given the various levels of training from expert trainers to farmer promoters then to farmers, copies of the climate information products and training materials were distributed to all farmers to avoid distortion of information (Doward et.al, 2015).

Resilience Assessment Benchmarking and Impact Toolkit (RABIT)

Developing countries has to face a growing series of short-term shocks (economic crises, climate events, violent attacks, health epidemics, etc), long-term trends (climate change, migration, economic restructuring, new technologies, etc) and countries should become more resilient to face the challenges. Resilience is defined as the ability of vulnerable systems, countries, regions, communities, value chains, organisations to withstand, recover from, adapt to, and potentially transform amid change and uncertainty. RABIT toolkit was created and field tested in two locations, viz., a low-income urban community in Costa Rica, and a low-income rural community in Uganda. RABIT is an appropriate tool for measuring community resilience, for visualising resilience, and for planning future resilience interventions. Its main contribution has been summed up as "3Ps":

1. Prioritization: visualisation and identification of priorities for future resilience interventions, including those based around information and communication technologies (ICTs)
2. Participation: ensuring the involvement of community members in resilience measurement and prioritization.
3. Progression: providing a quantitative foundation for resilience measurement, enabling measurement of the impact of interventions on resilience over time.
4. As a result, the project was able to develop a priority plan for strengthening both the resilience and the e-resilience of each community (Angelica and Heeks, 2016).

ToT approaches for CSA

Several extension approaches for CSA are cited in the literature; the major categories including the group extension approach, the mass media extension approach and the individual / household extension approach (Speranza, 2010). The choice of a particular extension approach is determined by the target audience, the available resources and the capacity of the facilitator, amongst other factors. Traditional extension methods within the mass media approach include use of radio, print media such as newspaper and pamphlets, and audio visual aids. In the group extension approach, there are demonstrations of agricultural practices, field days, farmer days, master farmer training, training workshops and meetings, study circles, exchange visits and farmer field schools. The individual extension approach involves house visits or individual farm visits (Ngara Todd, 2017).

Different projects used different approaches, strategies and methods to deal with the changing climatic conditions in the field situation or to help the farmers. Out of three projects studied, all the three projects used different methods for climate knowledge transfer based on the location/area where they worked. NICRA used Information and Communications Technology based platform to improve processing, sharing and use of knowledge around climate change adaptation in agriculture while CCA adopted the knowledge-informed, multidisciplinary and participatory approach which includes various sub components (Rupan et.al. 2018).

Rupan et.al, 2018 in her study on ‘Climate Smart Agriculture and Advisory Services: Approaches and Implications for Future’ mentioned some of the innovative extension approaches for Climate Smart Agriculture in NICRA, CCKN-IA and CCA project. The extension methods for transfer of climate knowledge were SMS or Short Messaging Services, Climate Wallpapers, Climate Voice Messages, Folk media, Use of Public Addressing System, Climate Group meetings, Exposure visits, Climate Workshops. Extension methods for learning includes Climate Field Group Visits, Farmer Interest Groups (FIGs), Climate Trainings, Informative Crop Calendar, Livestock Calendar, Block Contingency Planning, Information & Communication Tools and the Extension methods for capacity development were Climate Trainings, Climate Workshops, Field Demonstration, Climate-Smart Farmers Field Schools (CFFS), Weather-Based Insurance, Community Based Disaster Management (CBDM) approach, Village Level Custom Hiring Centre (CHCs), Jaldoot, community-level extension professional and Agro-meteorological Advisory Service.

Research Report Brief 1

MANAGE- Centre for Agricultural Extension Innovations, Reforms and Agripreneurship
January, 2018

Climate Smart Agriculture and Advisory Services: Approaches and Implications for Future

Rupan Raghuvanshi, Saravanan Raj, and Suchiradipta Bhattacharjee

Introduction: Climate change is emerging as a prominent issue in the world in current times. Changing climatic conditions are most severely affecting agriculture as it depends on local weather parameters like temperature, rainfall, humidity, etc. in long term. Climatic change could affect agriculture in several ways: productivity, in terms of quantity and quality of crops; agricultural practices, through changes in irrigation and agricultural inputs such as herbicides, insecticides and fertilizers; environmental effects, in particular in relation to frequency and intensity of water drainage, soil erosion, reduction of crop diversity; rural space, through loss and gain of cultivated lands, land speculation, land renunciation and hydraulic amenities; adaptation, as plants may become more or less competitive, such as flood resistant or salt resistant varieties of rice. World agriculture faces a serious decline within this century due to global warming. Since agriculture makes up roughly 16 per cent of India’s GDP, a 4.5 to 9 per cent negative impact on production implies a cost of climate change to be roughly up to 1.5 per cent of GDP per year. To alleviate some of the complex challenges posed by climate change, agriculture has to become “climate smart”, that is, sustainably increase agricultural productivity and incomes, adapt and build resilience to climate change, and reduce and/or remove greenhouse gas emissions, where possible. Climate-Smart Agriculture (CSA) contributes to the achievement of sustainable development goals. It integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges. Extension providers can play a major role in supporting CSA through the following: technology development and information dissemination, strengthening farmers’ capacity, facilitation and brokering, and advocacy and policy support. It contributes to achieving CSA by disseminating climate information and technologies on production practices for climate change adaption through innovative approaches, such as plant clinics and participatory video (Digital Green, case from India), climate smart villages, climate trainings or workshops, etc. So it is necessary to know the role of extension in CSA and what are the different extension methods used in CSA to help the farmers.

Fig. 1: Researcher exploring the drought area in Baramati

Methodology: Study was conducted in Ahmednagar and Pune districts of Maharashtra state of India because from pre-existing literature it was found that the state is one of the most vulnerable in the country. Two districts Pune and Ahmednagar were selected because three projects, National Innovations on Climate Resilient Agriculture (NICRA) by Indian Council of Agriculture Research (ICAR), Climate Change Knowledge Network in India (CCKN IA) by GIZ (technical cooperation with German development cooperation), GOI (Government of India, Ministry of Agriculture and Farmers Welfare), and Climate Change Adaptation (CCA) by Watershed Organisation Trust (WOTR) were working there. These three projects were selected to study the different extension approaches used by them to cope up with changing climatic conditions. KVK

Research Report Brief 5

MANAGE- Centre for Agricultural Extension Innovations, Reforms and Agripreneurship
January, 2018

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

Deepika, Saravanan Raj, and Suchiradipta Bhattacharjee

Introduction: FAO coined the term Climate Smart Agriculture (CSA) in preparation for the 2010 Hague Conference on Food Security, Agriculture and Climate Change which is a priority for addressing the need for adequate, nutritionally balanced food for a growing and more demanding population in a situation of resource limitation, climate change and weather variability. The dissemination and uptake of climate smart technologies, tools and practices is still an ongoing and challenging process for all the stakeholders involved viz., public sectors, private sectors, research institutions, policy makers, etc. Continuous involvement of the country administration, local leaders, NGOs, and civil societies is necessary to foster local enrollment and to 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. So, to answer these questions, a research problem titled “Climate Smart Agriculture towards Triple Win: Adaptation, Mitigation, and Food Security” was undertaken with the following objectives:

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

Methodology: The study was conducted in the districts of Bilaspur and Hamirpur of the state Himachal Pradesh as these two districts were found to be the most vulnerable ones as per the report on State Action Plan on Climate Change. Level of participation and involvement of different stakeholders will be determined by Stakeholder Analysis. The state department of agriculture was identified as the key stakeholder through review of literature and other stakeholders were identified through this key stakeholder.

Results and Discussions: Both national and state sponsored programmes functioning in the selected districts in the domain of climate change and its adaptation and mitigation are:

1. National Innovations in Climate Resilient Agriculture (NICRA)
2. National Mission on Sustainable Agriculture (NMSA)
3. Pardhan Mantri Fasal Bima Yojna (PMFBY)
4. H.P. Crop Diversification Project (JICA ODA Loan Project)

These programmes sustain the agricultural productivity through increase in the quality and availability of natural resources and increase the farmers’ adaptive capacity.

Stakeholder Analysis of the Programmes

A. National Innovations in Climate Resilient Agriculture (NICRA)

Power-Interest Matrix (NICRA): Stakeholders’ mapping have been done by this technique which led to know about the positions of the respective stakeholders. Fig. 1 clearly interpreted that KVK acted as a key-player as per the opinion of other stakeholders who were implementing and developing the plans, but state agriculture university tried to move to the key players’ area as they needed to have high power to make the programme successful. The major finding was that the input dealers were not very active in the programme as they were having low power-low interest and had to be improved as per the opinion of other stakeholders.

http://www.manage.gov.in/publications/reportbrief/MANAGE_Research%20Brief_1Rupan.pdf
http://www.manage.gov.in/publications/reportbrief/MANAGE_Research%20Brief__5Deepa.pdf

Table: AEAS methods for disseminating climate smart agricultural technologies to farmers in Maharashtra

S. No	Type of methods	Operational description	Who uses it	Strengths	Weakness
1.	Climate Awareness programmes/ Campaigns, Exhibitions,	• It is used to sensitise the people about climate change, its consequences and effects on farming. • Introduction about the different activities of the project	CCA NICRA CCKN-IA	Timeliness or frequency of information delivered	Take much time and efforts.
2.	Climate workshops	• Awareness creation for use of SRI method of rice cultivation, preparation of crop plan for the season, water budgeting to know the availability of water, resource mapping, promotion of poultry & goat farming particularly for women income generation. • Persuade farmers in adoption of technologies (SRI method of rice cultivation, preparation of crop plan for the season, water budgeting, resource mapping, promotion of poultry and goat farming particularly for women)	CCA NICRA CCKN-IA	Sensitise farmers about different components and activities of the project	Less participation of women farmers
3.	Climate Trainings,	• Provide various adaptation and mitigation practices to the farmers and to develop their skills trainings of field extension worker is also done to make them familiar about the project and its activities. • Extension agents trained and provided tablet applications for effective and timely dissemination of advisories.	CCA NICRA CCKN-IA	Skill building in farmers to identify and successfully use the climate-resilient livelihoods or adaptation & mitigation strategies	All the time farmers expect that they will get some free incentives
5.	Climate Farmers field schools (FFS),	• Climate-smart location specific interventions like use of drought-resistant variety, use of mulching, cultivation of less water intensive crop, goat and poultry raring, polyhouse cultivation was promoted.	CCA NICRA	Motivate the farmers to adapt the climate smart technologies	Some socio-cultural issues like caste system

6.	Field visits to progressive farmers,	• Visits progressive farmer's field that were using different adaptation practices like who were using in-situ moisture conservation technique, mulching, integrating farming system, doing polyhouse cultivation.	CCA NICRA CCKN-IA	• Sensitise the farmers & promote them to make use of various climate smart adaptation or mitigation strategies. • farmers were motivated to adopt these practices in their fields	Farmers were reluctant to go to the progressive farmer of their own village.
7.	Demonstration on different adaptation or mitigation practices,	• Method demonstration was conducted on the farmers field so that they get to know about the method of that particular practice like SRI of rice crop, preparation of organic slurry to improve the soil pH and organic carbon, in situ soil moisture conservation, mulching, use of water lock chemical, silage making etc.	CCA NICRA CCKN-IA	Shows the actual adaptability of the technology in the real field situation or real climatic conditions.	• Less dem onstration as per the requirement or area of farmers. • 100% adaption was not there.
8.	Dissemination of appropriate climate resilient technology such as portable soil testing kits, farm mechanization equipment for small holdings, grain storage bags, improved crop varieties etc), irrigation management,	• Promotion of zero tillage • Use of pheromone trap • Various farm implements were given to the different farmers in group like grass cutter, tiller, harrow etc. • Custom hire centre was established in the village to prove mechanical support to the farmers. • Some drought tolerance varieties of sorghum, bajra or rice was given to the farmers. • Hybrid breed of poultry vanraja, shrinidhi or khadaknath were distributed among the women farmers for income generation. • Bhagava variety of pomegranate and PKM 1 variety of drumstick were given to the farmers of Gogalgaon or Pimprilokai village of Rahata block under CCKN- IA project	CCA NICRA CCKN-IA	Promote the use of latest technology, use of resistant varieties or irrigation methods etc.	Farmers did not adopt the paid technologies.

9.	ICT supported network	• It was a important tool used in CSA • NICE Plate-form • Uses of mobile phone for SMS	CCA NICRA CCKN-IA	• Takes very less time to contact large number of peoples in a very short period of time. • It save the time of both service provider and farmers. • Very useful in critical weather condition to make farmers alert.	Most of the women farm-ers does not have mobile phones. In some villages there were network problem.
10.	Participatory crop planning	• It is done with the help of farm-ers. Contingency crop plans are technical documents containing integrated information on ag-riculture and allied sectors i.e., horticulture, livestock, poultry, fisheries and technological solu-tions for all the major weather related aberrations including extreme events viz., droughts, floods, heat wave, cold wave, untimely and high intensity rain-fall, frost, hailstorms, pest and disease outbreaks.	CCA NICRA	• Guides the farm-ers in their crop planning process. • Help farmers to grow the crops according to climatic condition. • Decreases the chances of crop failure hence en hance the farmer's income.	• Follow up is not there • All the farmers does not follow it. • Little bit variation is there according to the real field situation.
11.	*Jaldoot* - community level extension professional	• He acts as a local extension worker which has knowledge on all water related activities. He helped the farmers in differ-ent activities involved in water budgeting, construction of water ponds, bore wells, etc. • Helped the farmers mainly in planning their crops according to water availability.	CCA	• To sensitise the farmers about the needs to better manage the available water and use it efficiently. • Helps in entire process of water budgeting.	Single Jaldoot have to cover large area.

(Source: Rupan, R., Saravanan, R. and Suchiradipta, B. 2018. Climate Smart Agriculture and Advisory Services: Approaches and Implication for Future. MANAGE Discussion Paper 1, MANAGE-Centre for Agricultural Extension Innovations, Reforms and Agripreneurship (CAEIRA), National Institute of Agricultural Extension Management, Hyderabad, India)

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

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. The research was taken up in the vulnerable districts, Hamirpur and Bilaspur of Himachal Pradesh and studied Climate Smart Agriculture (CSA) programmes 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).

Key stakeholders:

1. Research institutes
2. Extension organizations
3. Academic institutions/Universities
4. Input dealers
5. Rural communities
6. Grassroots Administrative Units
7. Farmer organizations

Major roles of stakeholders:

1. Implementation
2. Funding
3. Problem analysis
4. Training and capacity development
5. Planning
6. Resource management
7. Organizing extension activities

Power and interest of the stakeholders in CSA innovation systems

Low Power/High Interest

- Producers/Producer collectives
- Extension organizations at block and village level
- Rural communities
- Grassroots administrative units

High Power/High Interest

- Research institutions

Low Power/Low Interest

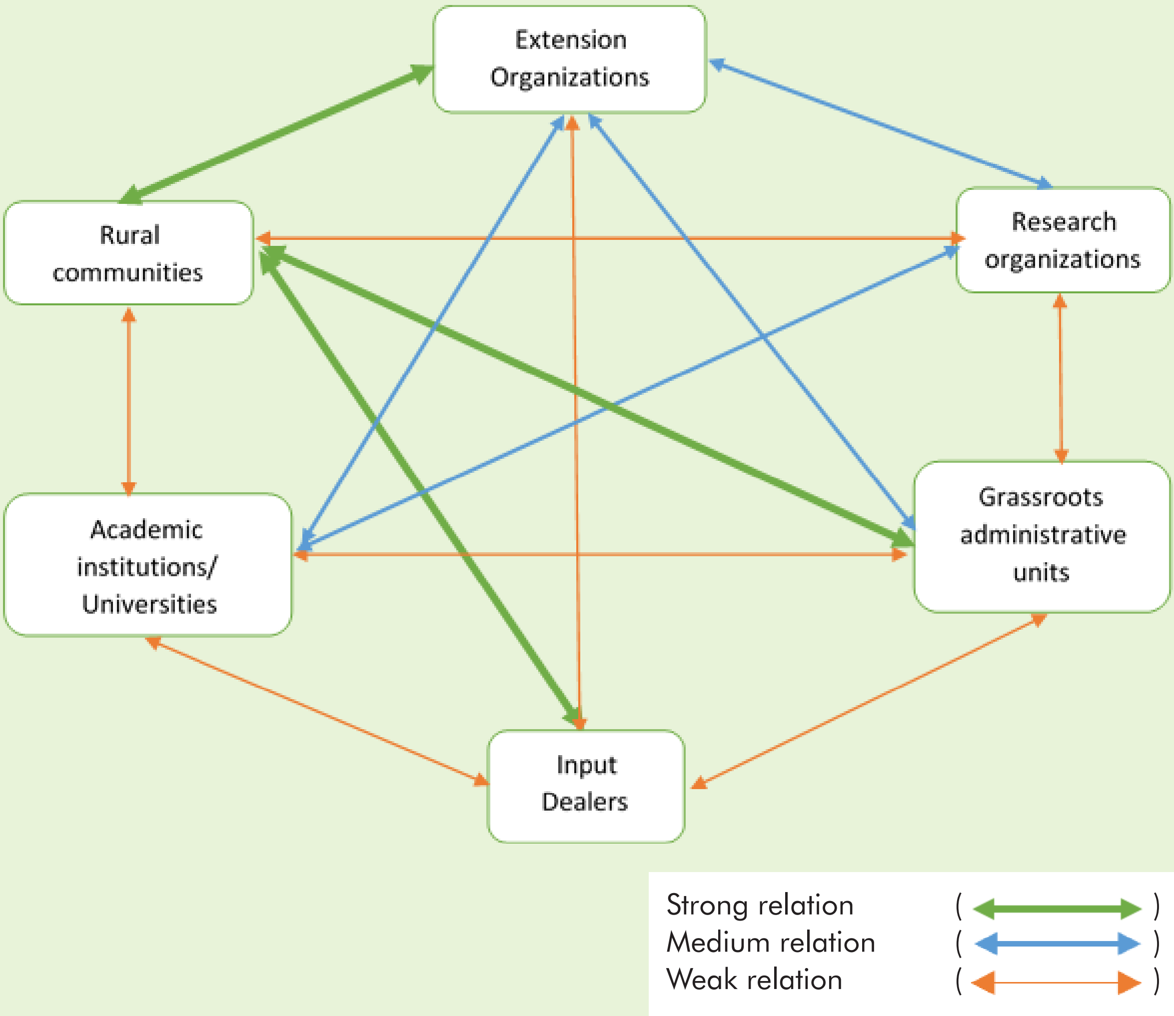
- Input dealers
- Academic institutions

High Power/Low Interest

- Extension organizations at state level

(Source: 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)

Relational analysis of stakeholders



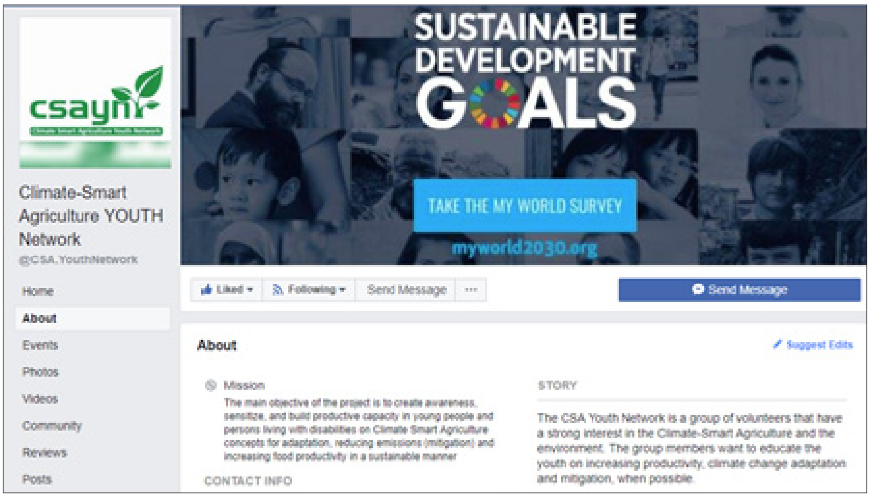
(Source: Deepika, Suchiradipta, B., and Saravanan, R. 2018. Climate Smart Agriculture towards Triple Win: Adaptation, Mitigation and Food Security. MANAGE Discussion Paper 5, MANAGE-Centre for Agricultural Extension Innovations, Reforms and Agripreneurship (CAEIRA), National Institute of Agricultural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

On the whole, when designing a CSA strategy extension agents must consider that, at the micro (farmer) level, adaptation strategies encompass a wide range of activities that will need to be evaluated and prioritized. Examples include modifying planting times and switching to varieties resistant to heat and drought (Phiri and Saka, 2008); developing and adopting new cultivars (Eckhardt et al., 2009); changing the farm portfolio of crops and livestock (Howden et al., 2007); improving soil and water management, including conservation agriculture (Kurukulasuriya and Rosenthal, 2003); integrating the use of climate forecasts into cropping decisions (Howden et al., 2007); improving fertilizer use and increasing irrigation (Howden et al., 2007); increasing labour or livestock input per hectare to increase productivity (Mortimore and Adams, 2001); increasing the storage of food/feed or the reliance on imports (Schmidhuber and Tubiello, 2007); increasing regional farm diversity (Reidsma and Ewert, 2008); and shifting to non-farm livelihoods (Morton, 2007).

Social Media in CSA

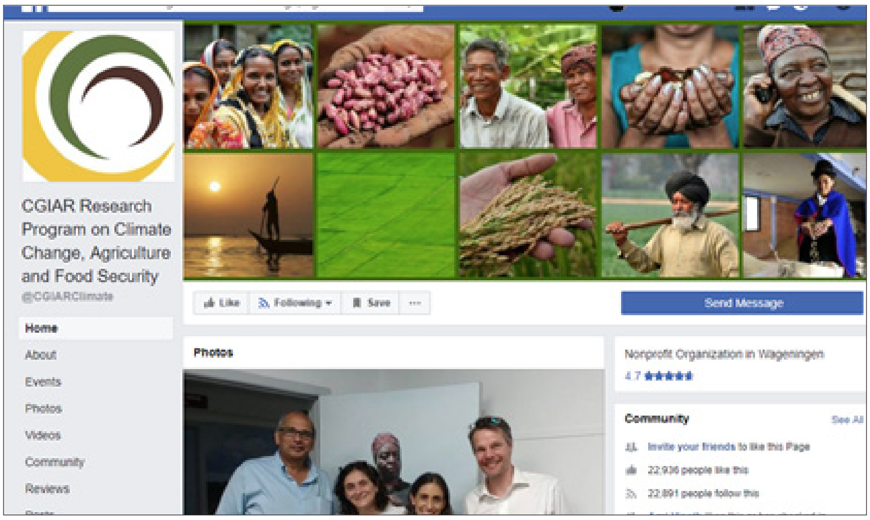
Facebook - Climate Smart Agriculture

Climate-Smart Agriculture YOUTH Network (www.facebook.com/CSA.YouthNetwork): The CSA Youth Network is a group of volunteers who have a strong interest in the Climate-Smart Agriculture and the environment. The purpose of the group is to raise awareness on Climate-Smart Agriculture among the youth for them to make sustainable decisions for the future especially in the agriculture sectors, to create awareness of the coming threats related to climate change and to make the youth aware of the contributions they can make within agriculture for a better future, especially applying climate-smart practices in agriculture and forestry.



CGIAR Research Program on Climate Change (www.facebook.com/CGIARClimate)

This facebook group aims to overcome the threats to agriculture and food security in a changing climate. With above 22,891 followers in February, 2018, it mostly discusses about the best researches in agricultural science, climate science, environmental and social sciences to identify and address the most important interactions, synergies and trade-offs between climate change and agriculture.



FAO policy support to Climate Smart Agriculture

FAO provides policy advice to inter-governmental processes and plays a unique role in raising awareness of the importance of agriculture in achieving food security under the new realities of climate change and population pressure. Coordination and integration between various sectors dealing with climate change, agricultural development and food security at national, regional and local level is a key requirement for creating an enabling policy environment. Providing incentives for adopting CSA, such as payments for environmental services, encourages farmers to take on climate-smart practices and to overcome initial investment barriers. FAO has identified the following two areas of intervention related to policies and planning for the adoption of climate Smart Agriculture.

FAO support countries to ensure that agriculture and CSA are included in mid to long-term development planning processes and investment decisions. **National Adaptation Plans (NAPs)** is to support medium to long term adaptation planning in the agriculture sectors, including forestry and fisheries. They will address how to integrate climate change adaptation into relevant new and existing policies, programmes and activities. **Intended Nationally Determined Contributions (INDCs)** are countries' commitments to reducing emissions and addressing climate change through various approaches, including through CSA, in the build up to the UNFCCC Conference of the Parties in December 2015. **Nationally Appropriate Mitigation Actions (NAMAs)** are nationally determined policies and actions that reduce net greenhouse gas (GHG) emissions.

FAO support to countries in creating the required policy, financial and enabling environment provides farmers, foresters and fishers with the knowledge and access to resources and services to move towards more sustainable, climate change resilient and economically viable production systems. FAO's Economics and Policy Innovations for Climate Smart Agriculture (EPIC) programme works with governments, research centres, universities and other institutional partners to support the transition to CSA by using sound economic and policy analysis (FAO,.n.d).

Climate Smart Agriculture in African policy processes

While the UNFCCC can establish the international policy framework for how agriculture is incorporated into future climate agreements, much policy development has to occur in national, regional and continental policy arenas. NEPAD18's Comprehensive Africa Agriculture Development Program (CAADP) is the key arena for ensuring that climate change is mainstreamed into agricultural development. At the national level, adaptation plans and mitigation strategies are being prepared. However, as noted in a recent analysis, the proposed strategies and actions for agriculture remain very general. Strategies to achieve and fully incorporate agricultural adaptation and mitigation into climate change strategies need more tangible, detailed measures that build on existing efforts and are calibrated to local conditions.

Implications for Agricultural Extension and Rural Advisory Services

The key concept of Climate Smart Agriculture is to provide location specific climate smart technologies. Multiple stakeholders i.e. from governments, civil societies, science and private sectors have to be involved in formulating the location specific technologies.

1. The focus of extension has to shift from transferring skills, technologies and knowledge related to the production of crops, livestock and forestry products to develop climate smart technologies with farmers, catalyzing and facilitating innovation processes.

2. Participatory methods and approaches such as participatory technology development, enables rural innovation and innovation platforms to develop and disseminate technologies and encourage innovation through multiple stakeholder engagement to ensure Climate Smart Agriculture.

3. There is a strong need for Climate Smart Agriculture researchers to tap local knowledge and to have a clear understanding of farmers' needs and problems in order to develop a close linkage with extension personnel.

4. Successful CSA implementation involves effective and efficient extension providers and systems, which will require major organization and institutional reforms in most countries as well as capacity building at organization and individual levels.

5. Implementation of CSA requires critical investment in relation to both on-farm capital and wider agricultural outreach programmes. All the agricultural extension service providers need to give priority to implement CSA technologies and also provide fund to develop those technologies.

6. The capacities of policy makers, extension agents, agricultural entrepreneurs and farmers need to be enhanced through different Climate Smart Agriculture training modules of in order to strengthen organizational and institutional capacities, such as coordination mechanisms.

7. Public - private partnerships can be encouraged to promote Climate Smart Agriculture. Government has to recognize and promote such partnerships through incentives and create an environment where farmers can do business with private sector.

8. Development of information hub related to climate-smart agricultural practices, technologies, etc. is essential. Success stories, case studies and initiatives of different stakeholders in various places can be shared in this cloud based pool. So that it can be accessed by farmers and other stakeholders across the globe.

9. A nodal agency on Climate Smart Agriculture at national level has to be established to monitor and play an important advocacy role at the local level in decentralized governance structures to ensure climate change remains high on the policy agenda and funds are allocated for CSA programs.

The implementation of CSA would involve changes in the behaviour, strategies and agricultural practices of millions of farmers worldwide. Farmers need support to understand the impacts of climate change and to adopt CSA practices. Rural Advisory Services (RAS) have a crucial role to play in linking farmers with sources of new information and tools so that they can transition to CSA practices (Simpson and Burpee, 2014).

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CGIAR Research Program on Climate Change Agriculture and Food Security (CCAFS): https://ccafs.cgiar.org/

Inter-Agency Working Group on Climate Smart Agriculture in International Development: https://rmportal.net/groups/csa/about-csa

Food and Agriculture Organization of the United Nations: http://www.fao.org/climate-smart-agriculture/en/

Global Alliance on Climate Smart Agriculture (GACSA): http://www.fao.org/gacsa/en/

World Bank: http://www.worldbank.org/en/topic/agriculture

Africa CSA: http://africacsa.org/

Farming First: http://www.farmingfirst.org/tag/climate-smart-agriculture/

CSA Youth Network: https://csayouthnetwork.wordpress.com/

National Institute of Agricultural Extension Management (MANAGE)
(An Organization of Ministry of Agriculture and Farmers Welfare, Govt. of India)
MANAGE-Centre for Agricultural Extension Innovations, Reforms and Agripreneurship (CAEIRA)
Rajendranagar, Hyderabad - 500 030, Telangana State, India
www.manage.gov.in

About the issue

As agriculture becomes climate smart, the need of hour is to gear up Research and Extension system empowering farmer to face the challenges posed by inevitable change of climate. The concept climate smart agriculture (CSA) has been recognised by national, international institutes and several initiatives were taken to develop climate smart technologies. But still, the dissemination and uptake of climate smart technologies, tools and practices is still largely an ongoing, challenging process.

Increasing the returns and benefits that agricultural producers derive from their production systems is an essential component of CSA and therefore also requires well-functioning and accessible extension advisory services. Climate Smart Agriculture needs to be mainstreamed into core government policy, expenditure and planning frameworks. This issue focuses on various approaches in agricultural extension and advisory services to facilitate Climate Smart Agriculture. It showcases examples where participation and inclusion have been integrated into extension approaches for the ultimate benefit of farming communities that were part of CSA initiatives.