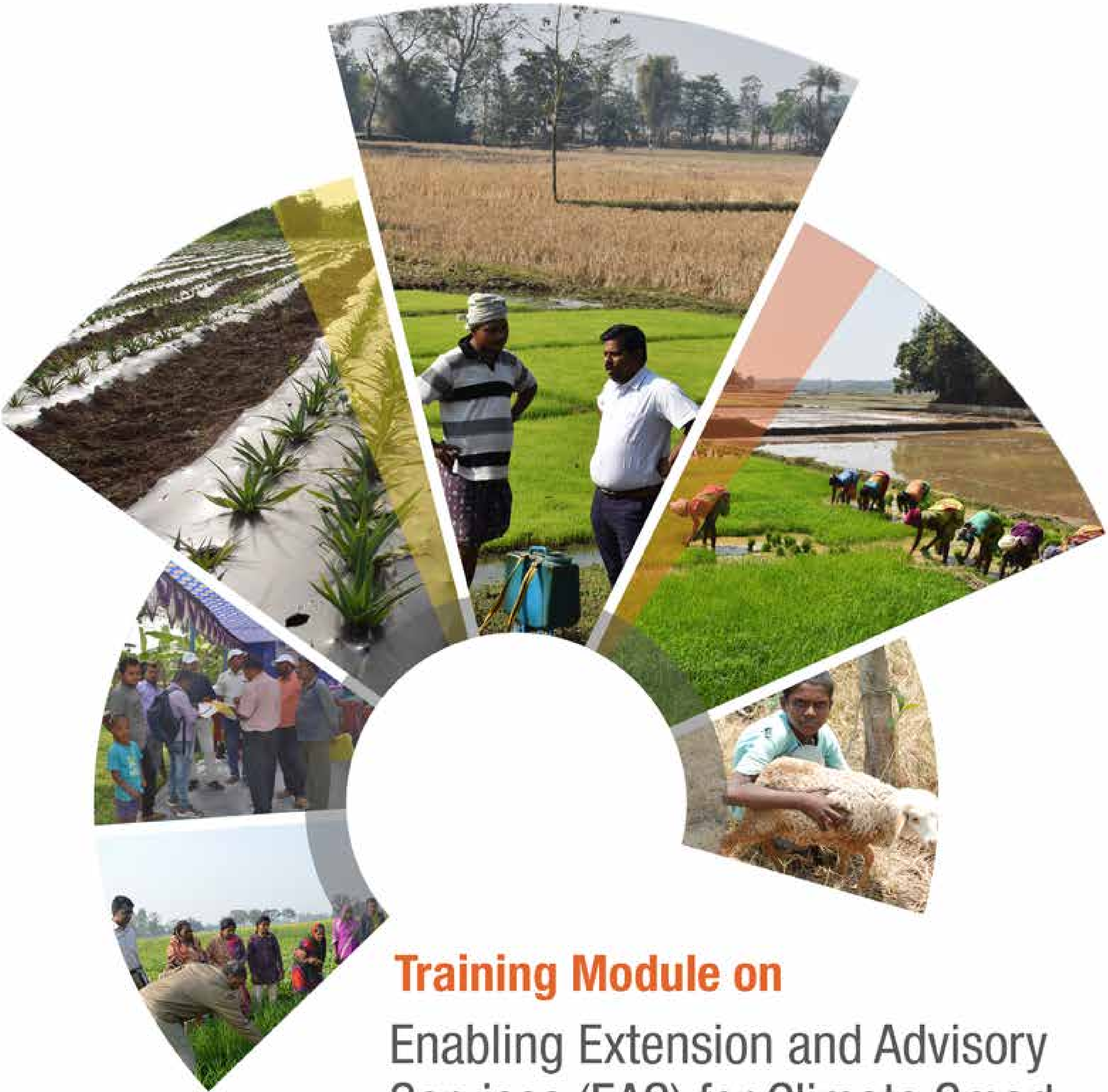

Training Module on

Enabling Extension and Advisory Services (EAS) for Climate Smart Agriculture (CSA)

CRISP

IRRI

The Centre for Research on Innovation and Science Policy (CRISP) was established in 2004 for undertaking research in the area of innovation policy in relation to agriculture and rural development (www.crispindia.org). CRISP also hosts the AESA (Agricultural Extension in South Asia) Network (www.aesanetwork.org)

The International Rice Research Institute (IRRI) was established in 1960 by the Ford and Rockefeller Foundations with help and approval of the Government of the Philippines. It is supported by government funding agencies, foundations, the private sector, and nongovernment organizations. Today, IRRI is one of 15 nonprofit international research centres that is a member of the CGIAR Consortium (www.cgiar.org) CGIAR is global agricultural research partnership for food –secure future.

The work described here was undertaken as part of the on-going, Government of Odisha funded project 'Increasing Productivity of Rice Based Systems and Farmers' income in Odisha'.

Training Module on Enabling Extension and Advisory Services (EAS) for Climate Smart Agriculture (CSA)

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February 2020

Training Module on **Enabling Extension and Advisory Services (EAS) for Climate Smart Agriculture (CSA)**

Preface

Agriculture is critical to the overall development and transformation of Odisha. With crops covering 35 per cent of the state's geographical area and more than 60 per cent of its workforce depending on farming for livelihood, the welfare of Odisha's people cannot be separated from its agriculture. The State Government is keen to increase agricultural production and raise incomes and productivity by leveraging science and technology, improving resource use efficiency, diversifying to high value agriculture and supporting efficient functioning of agricultural markets.

Extension and Advisory Services (EAS) play a major role in strengthening technical, managerial and organisational capacities of farmers, who need frequent renewal of capacities to deal effectively with the evolving challenges faced by rural communities. Based on a systematic Capacity Needs Assessment of EAS in Odisha, undertaken by the Centre for Research on Innovation and Science Policy (CRISP) and the International Rice Research Institute (IRRI) in 2018-19, a strategy was developed to address the identified capacity gaps.

Based on the prioritised capacity needs and recommendations from the Department of Agriculture and Farmers' Empowerment (Government of Odisha), CRISP and IRRI have developed this module on climate smart agriculture. It was pilot tested in a Training of Trainers Workshop organised during 18-20 September 2019 at the Institute on Management of Agricultural Extension (IMAGE), Bhubaneshwar, Odisha.

We hope that this training module would be used by facilitators in agricultural training centres and faculty of agricultural extension in the state of Odisha for developing capacities of extension functionaries to enable them to offer better support, advice and guidance to farmers and farmer organisations in gaining awareness, understanding and relevance regarding the linkages among climate, agriculture and food security.

Rasheed Sulaiman V

Ranjitha Puskur

Acknowledgements

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Director, Agriculture & Food Production, DAFE, Government of Odisha, for their valuable support in development of this training module.

Dr Onima V T, Research Officer, led the development of this module with support from other members of the CRISP team (Ms Nimisha Mittal and Dr Rasheed Sulaiman V) and Dr Ranjitha Puskur from IRRI. Our sincere thanks to them and to all those who contributed ideas, cases, experiences, tools and frameworks related to climate smart agriculture, especially Dr Sreenath Dixit (Head, International Crops Research Institute for the Semi-Arid Tropics -Development Center, Patancheru, Telangana) , Dr PK Mahapatra (Former Dean, College of Agriculture, Orissa University of Agriculture & Technology), Rema K Nair (Deputy Director Of Agriculture, Idukki, Kerala) who also served as resource persons during the Training of Trainers (ToT) workshop we organised on this topic.

The ToT workshop was held during 18-20 September 2019 at the Institute on Management of Agricultural Extension (IMAGE), Bhubaneshwar, Odisha, with a select set of participants identified by DAFE. We sincerely thank the participants of this ToT workshop for their inputs on the content as well as the process suggested in this training module.

We appreciate the contributions of Dr Mukund Variar, State Coordinator, IRRI, Odisha, for his support in organizing the training and development of the module. Our special thanks to Mr Kishor Kumar Behera, Senior Specialist-Partnership Management, IRRI, for his support in organising the ToT workshop.

Background

This Module is intended to assist trainers engaged in capacity development of the agricultural Extension and Advisory Services (EAS) staff on linking farmers to more efficient climate smart agriculture practices/ technologies. Climate change has massive impact on the agricultural sector. Climate smart agriculture is designed to overcome the challenges faced by climate change: to sustainably increase agricultural productivity and incomes; adapt and build resilience to climate change; and reduce and/or remove greenhouse gas emissions, where possible. Extension and advisory services need to promote climate smart agriculture approach by integrating wide range of concepts, information and practices from different disciplines and stakeholders. EAS need to create awareness, understanding and relevance of linkages between climate, agriculture and food security.

Module Overview

This training module has a number of sub-modules and all of them are made up of a number of sessions, each embarking upon specific topics in climate smart agriculture.

- Unit I: CLIMATE CHANGE AND AGRICULTURE: IMPLICATIONS FOR EXTENSION
- Unit II: BASICS OF CLIMATE CHANGE AND CLIMATE SMART AGRICULTURE
- Unit III: ROLE OF EAS IN PROMOTING CSA
- Unit IV: CLIMATE CHANGE AND DISASTER RISK MANAGEMENT
- Unit V: GENDER AND CLIMATE SMART AGRICULTURE
- Unit VI: TECHNOLOGIES FOR CSA
- Unit VII: APPROACHES AND TOOLS OF EAS FOR CSA
- Unit VIII: EAS IN UPSCALING CLIMATE SMART AGRICULTURE

Most sub-modules/units are arranged in the following order: starts with objectives, then introduction of the content, followed by a detailed discussion on the content, and finally providing examples through cases. References/further reading, tools and exercises are provided at the end of each unit. The outline of the four-day training programme has also been provided in the module for ready reference.

How to use this training module

This four-day training of trainers (TOT) module is designed for approximately 25-30 participants.

Trainers/Facilitators can use the material and exercises in this module, and can also add locally relevant cases and examples while designing and implementing training programmes. To remain relevant, the trainers need continuous updating so that they stay aware of new material and sharpen their training skills. Many topics and techniques described in this module are accompanied by training notes (e.g., tips for facilitators). These provide information to help trainers understand why a topic is important or how specific techniques will enhance learning by the participants.

Module Performance Outcomes

The expected outcome of this training module is the development of competent and confident trainers having the skills necessary to design and implement a training programme on climate smart agriculture.

Needless to say, facilitating an effective training course on climate smart agriculture not only involves understanding the technical content on climate change and the role of extension, but also a range of communication techniques to facilitate interaction and cross learning among the participants/trainees. In other words, an effective trainer should be conversant with a variety of topics and, at the same time, be competent enough to be a good facilitator.

A trainer should review the material ahead of time and plan the appropriate approach to introduce the different topics and the amount of time that is needed for each session.

Tips for Facilitator - Guiding principles for conducting an effective training programme

- *Correct selection of participants for a training programme is vital to the success of any workshop.*
- *Clarity in communicating all aspects of the training programme to the participants prior to reaching the venue is critical. This could begin with the introductory invitation letter itself – explaining the purpose of the workshop and highlighting the importance of attending it.*
- *Once the participants affirm their availability to attend the training programme, it is important to continuously engage their interest by sending them relevant materials, such as the background paper, self-assessment questionnaire, programme schedule, and brochure periodically.*
- *The logistics should be undertaken by the organizers so that the participants are not hassled by any of the minor details and have no deterrents with regard to attending/not attending.*

Tool kit

Training Materials: *For executing the training programme the following materials are required for trainers and trainees: Training module, card sheet in different colours, poster papers, sketch pens, marker pens, white boards, white board markers, offset paper, board pins, booklet, hand out, books and literature related to market linkage and value chain.*

Training Aids: *Multimedia projector, microphone, projection screen, laptop, computers, printers, scanner, digital camera, voice recorder, etc.*

Training Methodology: *The training programme will be implemented using the participatory approach mentioned here. Some of the major methods that will be used during the different sessions are: Interactive lectures with multimedia presentation and participation through Q & A, group and individual exercises, general lectures and lectures followed by discussion, brain storming, small and large group discussions, experience sharing, field visits, etc.*

Suggested Outline of the Training Program

	DAY 1	
Session 1 1000-1100	**Introduction to the Workshop**	
	Welcome	IRRI/IMAGE
	Self-Introduction - Participants	
	Workshop Objectives and Outcomes	CRISP
Session 2 1100-1315	**Climate Change and Agriculture: Implications for Extension**	
1100-1130	Climate Change and Agriculture	Video Card Exercise
1130-1145	Tea Break & Group Photo	
1145-1315	Basics of Climate Change and Climate Smart Agriculture	PPT
	Role of EAS	Group Work
	Plenary, Q & A	
1315-1415	Lunch Break	
Session 3 1415-1700	**Role of EAS in Promoting CSA**	
1415-1700	Why Extension for CSA?	PPT
	EAS Roles in Enhancing Sustainable Productivity Supporting Adaptation and Promoting Mitigation	
	Learning from Three Cases of CSA	Group Work
1530-1545	Tea Break	
1545-1630	Plenary, Q&A	
1630-1700	Sharing of Experiences	Participants
	DAY 2	
1000-1015	Recap	
Session 4 1015-1130	**Technologies for CSA**	
1015-1115	Agronomic Practices to Support CSA	*Guest Speaker (Experts with knowledge and experience in particular topics)*
1115-1130	Q&A	
1130-1145	Tea Break	
Session 5 1145-1300	**State Action Plan for Climate Change (SAPPC), Odisha**	
1145-1300	SAPCC and Agriculture - Implications	PPT
		Group Discussion
1300-1400	Lunch Break	
Session 6 1400-1530	**Gender and CSA**	
1400-1410	The Forgotten Women in India's Climate Plans	Video
1410-1430	Implications/Inference	Card Exercise
1430-1530	Discussions, Q&A	
1530-1545	Tea Break	
Session 7 1545-1700	**Climate Change and Disaster Risk Management**	
1545-1615	Disaster Risk Management and the Role of EAS	Guest Speaker
1615-1630	Q&A	
1630-1700	Sharing of Experiences	Participants

DAY 3		
1000-1015	Recap	
Session 8 1015-1130	**Extension Approaches for Upscaling CSA**	
1015-1115	Innovative Extension Approaches for Upscaling CSA	Guest Speaker
1115-1130	Q&A	
1130-1145	Tea Break	
Session 9 1145-1300	**Upscaling CSA: Learning from Case Studies / Innovation Management for Upscaling CSA**	
1145-1230	Case Analysis	PPT/ Group Work
1230-1300	Plenary	
1300-1400	Lunch Break	
Session 10 1400-1700	**Fieldwork/Exposure Visit**	
DAY 4		
0915-0930	Recap	
Session 11 0930-1130	**Key Learnings from Fieldwork**	
0930-1100 1100-1130	Presentations/Plenary Q&A	
1130-1145	Tea Break	
Session 12 1145-1300	**Feedback /Key Learnings from Training**	
1145-1215 1215-1245 1245-1300	Trainers' Feedback Trainees' Feedback Sharing Experiences	
1300-1400	Lunch	
Session 13 1400-1530	**Valedictory Session**	
1400-1500 1500-1530	Certificate Distribution Concluding Remarks/Vote of Thanks	

Contents

List of Figures

List of Tables

List of Boxes

List of Cases

Unit I:
Climate Change and Agriculture: Implications for Extension

Objectives

- Discuss the likely effect of climate change in agriculture
- Provide an overview on the role of EAS in the climate change scenario

Tips for Facilitator

- *The facilitator should set the scene for the four-day workshop by introducing the objectives of the workshop and emphasizing the need for promoting climate smart agriculture.*
- *He/she can use the exercise of calculating individual carbon footprint which helps participants to reflect on their lifestyles. This can be followed by an ice breaker exercise so as to get the participants ready for the training.*
- *The facilitator should guide the participants in a participatory exercise in order to establish a few do's and don'ts (for instance, keeping mobile phones on silent mode) for the duration of the workshop so as to ensure optimum utilization of time and resources.*
- *He/she should emphasise that the training programme is to enhance the understanding of participants on the role of extension and advisory services in promoting and upscaling climate smart agriculture.*
- *He/she should apprise the participants that this training programme is pitched towards gaining adequate expertise on assisting farmers and other actors (both core and supporting) in adapting to the changing climate and building a climate resilient future for farmers.*

Introduction

Climate change is no longer some faraway problem, it is an immediate challenge for this generation and it is imperative to act before it's too late. As stated by the Intergovernmental Panel on Climate Change (IPCC 2007), climate change is 'Unequivocal'. It is not only a major global phenomenon, but it is also an issue of great concern to a developing country like India. In India, according to the India Meteorological Department (IMD) data released by the Ministry of Statistics, average temperatures have risen by 0.6 °C between 1901-10 and 2009-18. At an annual level, this may seem trivial, but projections further into the future paint a more alarming picture. Climate impacts in India are not uniform — melting Himalayan glaciers will produce floods in north India; erratic monsoons will create droughts in peninsular India. Climate change can be closely linked to the economic growth and development of a nation. As agriculture stands at the heart of the Indian economy and provides food and livelihood activities to much of the Indian population, Indian agriculture is critically exposed to the looming threat of climate change.

The agriculture sector is the sector most prone to climate change because the climate of a region determines the nature and characteristics of its vegetation and crops, since temperature, sunlight, and water are the main drivers of crop growth. Increase in the mean seasonal temperature can reduce the duration of many crops and hence lower the final yield. Agricultural production systems are extremely sensitive to climate change events, such as changes in temperature and precipitation, which may then lead to outbreaks of pests and diseases – thereby reducing harvests and ultimately affecting the food security of the entire country. Climate change has the potential to hurt everyone, but one particularly vulnerable group is farmers.

Agriculture, especially in India, greatly depends on favourable weather conditions; so climate change can significantly hurt agricultural productivity. Consequently, a farmer's ability to adapt to climate change becomes crucial. Farmers need support to understand the impacts of climate change and to adopt Climate Smart Agriculture (CSA) practices. Extension and Advisory Services (EAS) 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). Khajuria and Ravindranath (2012) emphasised the importance of extension and advisory services in the climate change scenario in education and innovation transfer, enhancing farmer capacity to respond to climate change issues, and transferring climate change-related innovations to rural areas.

Discussion

How does climate change affect agriculture, and how does agriculture contribute to climate change?

Climate change negatively affects agriculture and the food production system but we should also be aware that agriculture and food production directly contributes to climate change.

The indiscriminate use of fertilisers, pesticides, and insecticides has greatly increased the quantity of greenhouse gases in the environment, and air pollution is exacerbated by stubble-burning. From 1970 to 2014, greenhouse gas emissions increased by 80%; 33 lakh tons of methane is released by paddy fields and 0.5-2 kg nitrous oxide is released per hectare (of paddy fields). It is estimated that 75-80% of the total nitrous oxide gas that is emitted comes from chemical fertilisers. According to one estimate, 500-550 tons of crop stubble is generated per year in India. According to another estimate, the amount is 600-620 tons. Around 15.9% of that is burnt every year, which severely exacerbates pollution, according to the ministry of agriculture. Stubble-burning releases greenhouse gases such as carbon dioxide, methane and carbon monoxide, which contribute to global warming. Burning a ton of paddy stubble releases three kilos of particulate matter (PM), 60 kilos of carbon monoxide, 1460 kilos of carbon dioxideand two kilos of sulphur dioxide. Forty percent of the stubble that is burnt is of paddy,

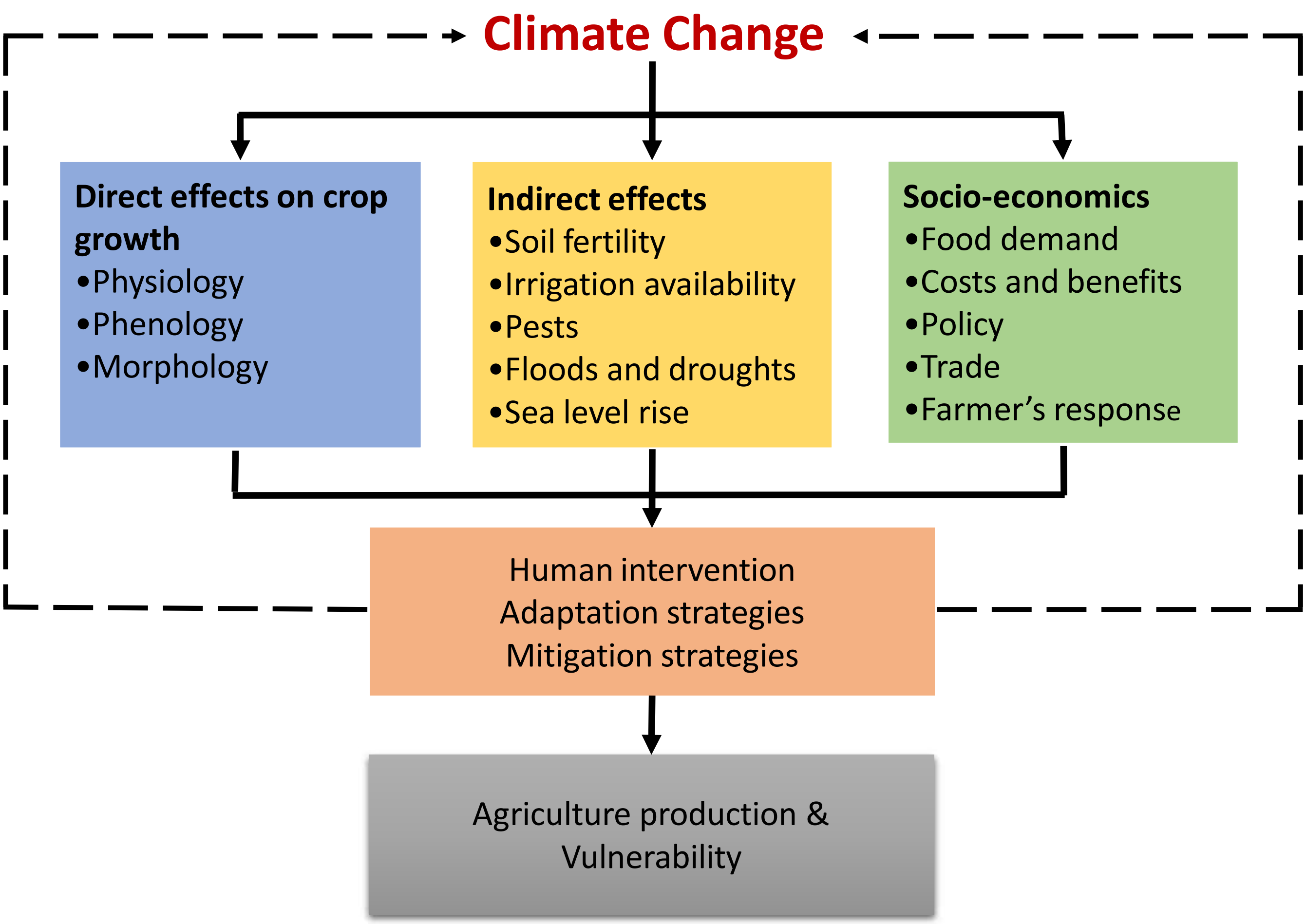


Figure 1: Assessment of Vulnerability of Agriculture to Climate Change

22% is wheat stubble, and 20% is sugarcane stubble. The indiscriminate use of pesticides and insecticides is causing air, soil and water pollution. Although the use of pesticide in India – 0.6 kg per hectare – is the lowest in the world, most pesticides are used without taking any precautionary measures, which is why they adversely affect humans, animals, soil, water, and air (Mishra 2019).

On the other hand, all natural hazards, floods, droughts and tropical storms affect the agriculture sector most, showing the severe impact of climate-related disasters. Drought causes more than 80 percent of the damage in the agriculture sector, especially on livestock and crop production. Tsunamis and storms cause much damage in the fisheries sub-sector, while floods and cyclones are responsible for most of the economic loss with regard to forestry. Disaster risk reduction and climate change adaptation are closely intertwined, and in agriculture they should be addressed in an integrated manner (FAO 2018).

Agricultural productivity is sensitive to two broad classes of climate-induced effects: (a) direct effects from changes in temperature, precipitation, or carbon dioxide concentrations; and (b) indirect effects through changes in soil moisture and the distribution and frequency of infestation by pests and diseases. Therefore impact can be assessed within three major areas, i.e., Environmental, Biophysical, and Socio-economic (Khajuria and Ravindranath 2012). (See Figure 1).

What is the biggest issue that farmers in India are facing today?

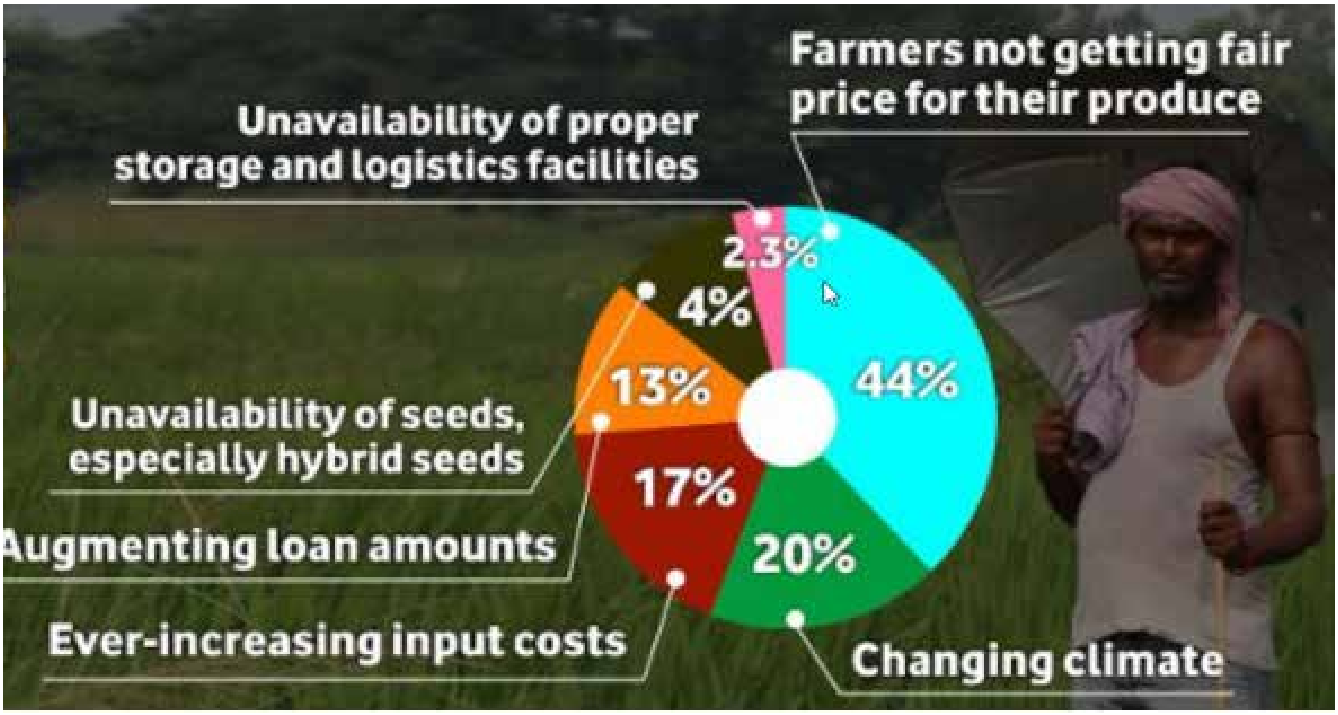
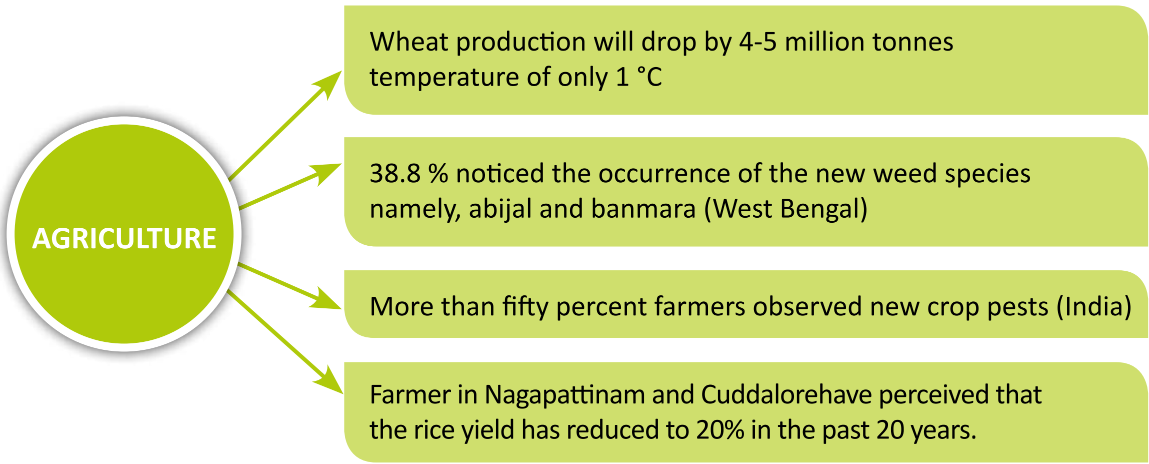


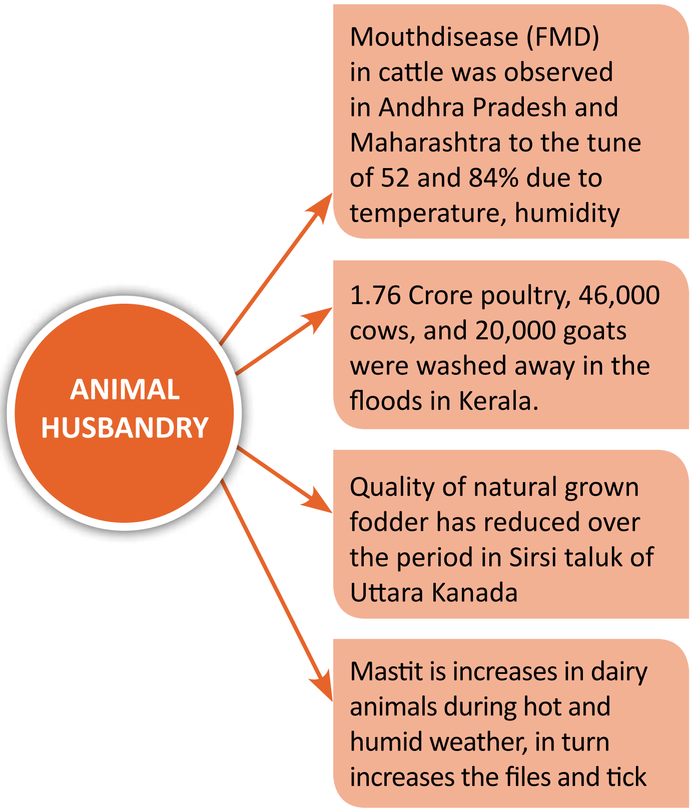
Figure 2: Issues faced by farmers in India

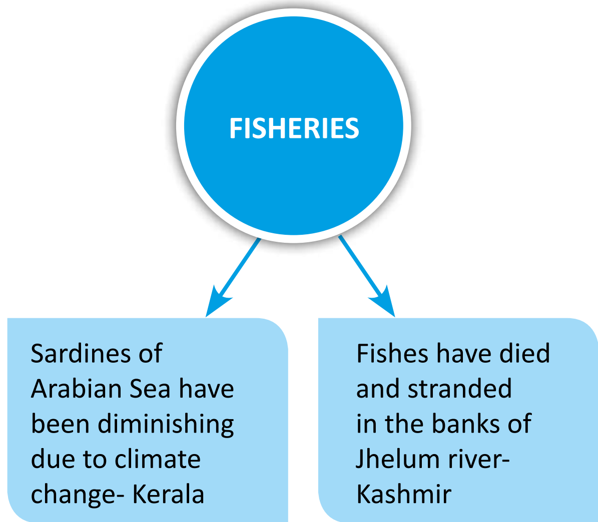
In a unique national rural survey conducted by Gaon Connection (2019) in 19 states of India, every fifth farmer blamed the changing climate for adverse impacts on farming. These included crop failure, loss in crop productivity, damages to standing crops, new pest attacks, and a changing cropping pattern.

Is Odisha a climate change hot spot?

Agro climatically, Odisha is prone to extreme weather events such as floods, droughts and cyclones. The State has been declared as 'disaster-affected' for 95 years of the last 105 years – floods have occurred for 50 years, droughts for 32 years, and cyclones have struck the state for 11 years (Patel 2016). Odisha's seasons have all but vanished, its trees have altered their flowering time, and the farmers have changed their farming practices. Not only this, of the six seasons prevalent, there seems to be only two – summer and monsoon – and these have their harmful effects on the farmlands of the State. Autumn, spring, and winters have slowly vanished from the memory of people. While summers have become longer, winters have become warmer and rains have shortened from over 120 days to 90 days while becoming erratic beyond a point (Jena 2017).







Source: *NATCOM – National Communication 2004: NATCOM Final Report. g (Available at http://www.natcomindia.org/natcomreport.htm)*

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

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Climate has a major impact on the food grain production of Odisha State. About 70-75% of the state's population is rural and depends upon agriculture. Odisha is rainfall dependent as its irrigation network does not cover the entire state. With a water dependent crop, rice, as its main staple, the agriculture sector is vulnerable to the vagaries of climate-induced weather changes. Food security is also threatened in different parts of Odisha due to climate change-induced disasters. About 70% of the total cultivated area in the state is drought-prone.

The number of extremely hot days in Odisha is likely to rise by 30 times of what it is today by 2100, the highest increase in hot days among all the States of India (CIL 2018). Rise in temperature and sea level has made agriculture vulnerable as the gushing seawater combined with erratic rain often destroy the crops. Seawater is more often rushing into the agricultural land filling it with saline water, which directly affects the farmers and slowly weakens the productivity of the State. As per Global Environmental Negotiation journal, if the sea level rises by one meter from the

Odisha Climate Change Action Plan 2018-23: Proposed Activities

- *Continue the livelihood-focused, people-centric integrated watershed development programmes in rain-fed areas;*
- *Establish an institutional delivery mechanism to promote best practices on climate change;*
- *Capacity building of extension personnel;*
- *Create awareness among farmers of climate change adaptation;*
- *Encourage the adoption of climate-resilient cropping techniques;*
- *Increase knowledge and capacity (of farmers);*
- *Increase the area under fruit crops;*
- *Develop water-efficient micro-irrigation methods;*
- *Establish a seed bank (village level) and an automated weather station;*
- *Document indigenous technical knowledge (ITK) in agriculture;*
- *Promote system of rice intensification (SRI), crop diversification, and green energy efficient models for farmers;*
- *Continue liaison work with the NCCP and National Mission on Sustainable Agriculture (NMSA).*

current level, 1,70,000 hectares of cultivable land in Orissa will get submerged. The Central Ground Water Board (CGWB) has clearly indicated that the groundwater of 24 out of 30 districts in Orissa is depleting (Pati 2009). Agriculture across the coast of Odisha is now facing a serious climate emergency. Between 2011 and 2015, the state witnessed two severe cyclones — Phailin in October 2013, and HudHud in October 2014 — which caused extensive damage to crops and infrastructure, especially in coastal districts. Even though human casualties were minimal (because of the State's deft handling of such disasters), the damage to crops and livestock couldn't be prevented.

Climate Change & Disasters: What EAS could do?

Ideally, EAS being responsible for serving the farming community should be the primary stakeholders in helping out farming communities during disasters. EAS can help communities because no other organization has the geographic distribution, access to research-based practices, local credibility, capacity, and mission to address the depth and breadth of community needs after such events (Kerr et al. 2018). At the time of a disaster, a state's Extension Service has the opportunity to be a local beacon of recovery while working side-by-side with others in the community. Serving in this way helps extension service grow stronger (Boteler 2007; Cathey et al. 2007). Moreover, farmers trust EAS

as a credible source of locally relevant information, and appreciate extension's effective connections with other organizations (Eighmy et al. 2012). As trusted members of the communities they serve, EAS are strongly positioned to share mitigation and adaptation strategies with their clients (Prokopy et al. 2015). The major strengths of EAS are the dedicated extension personnel and the extension model that includes partnerships, state-wide networks of offices, and a unique focus on assessing farming community needs (Cathey et al. 2007).

To support the farming community in the scenario of climate change there is a need for increasing literacy among extension professionals in every sector – on potential regional impacts and adaptation strategies – with regard to climate change. This is vital to producing high-quality relevant programs for addressing climate-related risks. Given the urgency of addressing climate related issues and the range of climate-related perspectives among extension professionals, thoughtfully designing programmes to build climate literacy across and within climate-perspective groups are a critical path forward (Clifford& Monroe 2018). EAS need to develop capacities so that extension professionals can assist effectively at all stages of disaster management, viz., preparedness, response, recovery, and mitigation. EAS can promote disaster resilient practices among farmers, facilitate rural/local agriculture innovation systems to mitigate disaster, and educate farmers on standard operating procedures (SOPs) to get post-disaster relief services and in-kind materials. EAS can also scout around for relief materials, aid, and other contributions, through the corporate social responsibility (CSR) system. To revive human and livestock habitats, health and agriculture, EAS can train and facilitate the people – involving faculties, scientists including students of agricultural research and academic institutions, and other stakeholder institutions.

Conclusion

Recurrent natural disasters in the form of floods, droughts, storms, landslides, etc., affecting millions of people every year evidently showcase the implications of climate change in the livelihood of populations. This unit's attempt was to create awareness among extension professionals regarding the seriousness of climate change, so as to enhance their confidence in addressing these issues.

Exercises

Exercise 1

Ice Breaker Exercise

1. What do you already know and what do you expect to know?

A. To briefly determine what participants already know:
The participants can answer a few simple questions like,
What is climate change?
What causes climate change?
How does climate change affect you?
Is there anything you can do to stop climate change? And more can be added.
This will be useful to gauge the level of knowledge in the participants before you start the training program.

A. To ascertain what participants expect from this workshop:
Each participant can share their expectations verbally and the trainer can write it on a flipchart, and group together similar expectations. Later, when giving the overview of the training programme, the trainer can refer back to this sheet and show which sections aim to answer/cover which expectations. If there are expectations that will not be covered, explain why and/or explain that they will possibly be included in future training programmes.

Exercise 2

Calculate your carbon footprint

To calculate individual carbon footprint, introduce this website to the participants: Carbon Footprint Ltd. at http://www.carbonfootprint.com.

Allow time for participants to view the website, then direct them to the 'Calculate' function and proceed accordingly. Participants can choose specific time periods to calculate, e.g., one year, one month, or the carbon footprint associated with this programme. It would be better if all the participants follow a uniform time period. Once the participants are done with their calculations, make them think it through in case they want to make changes in their lifestyle to lower their carbon footprints. They can reflect on the necessary changes required in their lifestyles. Now ask them to re-do the exercise to calculate the improved carbon footprint value using the same time period. Each of the participants should display their carbon footprint calculations at the training venue. This exercise can generate interesting and reflective conversations throughout the modular training process.

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Unit II:
Basics of Climate Change and Climate Smart Agriculture

Objectives

- Discuss the key vocabulary related to climate change;
- Understand the concept of climate smart agriculture.

Introduction

Climate change is the most pressing issue of our time. The unpredictable weather patterns, shorter growing seasons, droughts, floods, extreme temperatures, and increased exposure to pests and crop diseases pose intimidating problems to farmers around the world. Stepping up and facing the many challenges in agriculture in not easy. However, the solution may lie in climate smart agriculture (CSA). CSA broadly works on three parameters. These are sustainably increasing agricultural productivity and farmers' incomes, adapting to climate change, and reducing greenhouse gas emissions (GHG), wherever possible. This new concept now dominates current discussions in the field of agricultural development because of its ability to unite the agendas of the agriculture, development, and climate change communities under one brand.

Is climate smart agriculture different from sustainable agriculture? No, rather it's a way of combining various sustainable methods to tackle specific climate change challenges of a specific farming community. In reality, there is much confusion over what the term 'Climate Smart Agriculture' really means, and whether it is actually benefiting farmers and food systems in the face of climate change. Here, this unit tries to provide a clear understanding of the terms related to climate change and the concept of CSA.

Discussion

To understand what climate change really means, it is important to understand key concepts and the vocabulary most commonly used by climate change practitioners.

When someone says, "It is raining a lot today," or "It has been very rainy this season," they are talking about the weather. When someone says, "It always rains here for six months of the year," or "It never snows here," they are talking about the climate.

Weather is the state of atmospheric conditions at a particular place and time. The most common aspects of weather are felt by everyone during the course of a day and include rain, humidity, wind, sunshine, cloudiness, and temperature; but also include extreme events such as tornadoes, droughts and tropical cyclones. Weather is dynamic and can change within a very short period of time, even within the same day.

Climate is the set of weather conditions prevailing in an area over a long time, typically three consecutive decades (IPCC 2007). Several factors contribute to the definition of climate, including long term averages of temperature and precipitation, but also the type, frequency, duration, and intensity of weather events such as heat waves, cold spells, storms, floods and droughts.

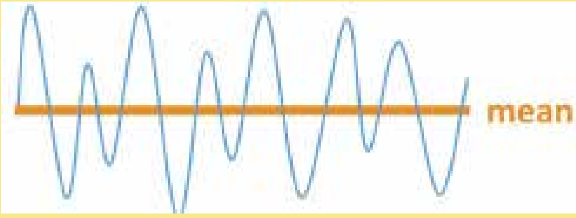
Climate variability is the natural fluctuation within the climate, including swings above and below the mean state and other parameters. It reflects the different weather conditions over a day, a month, a season or a year.

Climate Change refers to a significant variation in either the average state of climate or in its variability, persisting for an extended period (typically

If we consider rainfall in a given period in a particular region of the world, the variability can be low, meaning that there is not much difference in quantity or timing of rains from one year to another. In another region, there may be high variability, meaning that rainfall quantity swings from far below average to far above average from year to year, and the timing is unpredictable. Climate variability affects weather conditions including cyclone activity and temperature, as well as rainfall. Climate variability results from natural internal processes within the climate system, such as the El Niño Southern Oscillation or from variations in natural external forces, such as volcanic eruptions.

Box 1. Climate Change vs. Climate Variability

The main difference between climate variability and climate change is that a trend over a time scale indicates a change in climate. While fluctuations over shorter terms – days, seasons, years or several years – and in cycles is climate variability, a consistent linear trend will define climate change as patterns shift over decades. Climate change is detected when the climate – the long-term pattern of climate variability – and the mean exhibit significant measurable changes. For example, on average the climate gets warmer or cooler, or wetter or drier, over decades. Climate variability averages out as climate over years in a steady state. Climate change averages out to a changing trend over decades.



Variability

Change

Source: *FAO, 2018*

decades or longer). Natural processes may cause climate change or be caused by external (human-related), events that cause long term changes in the composition of the atmosphere or in land use. Note that the United Nations Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. The UNFCCC thus makes a distinction between 'climate change' attributable to human activities and others arising due to natural causes (IPCC 2007).

Climate Change Impact is the resulting effect of global warming related to change. Assessing this impact/change includes the use of climate data, such as temperature, rainfall and the frequency of extreme events; and non-climatic data, e.g., the current situation on the ground for different sectors including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity, and coastal zones as a result of change.

Climate Change Mitigation should be thought of as human actions to reduce the intensity or severity of climate change. Actions are expected to result in the decrease of radiation by decreasing the amount of greenhouse gases in the atmosphere – thus reducing the effects of global warming. Most often this is done by reducing sources of greenhouse gas emissions, or by increasing sinks – a natural or artificial reservoir that accumulates and stores 'carbon' for an indefinite period. Examples of reducing a 'source' would include using fossil fuels more efficiently for

Box 2. Climate Change Mitigation vs. Climate Change Adaptation

Both climate change mitigation and adaptation are focused on lessening the impact of climate change; just from different angles of view. Climate change mitigation focuses on addressing the root problem cause of global warming, i.e., decreasing the amount of greenhouse gases in the atmosphere. Climate change adaptation has a focus on actions to lessen the impact of global warming on human and natural systems despite climatic conditions and/or atmospheric greenhouse gas concentrations. In reality, addressing global warming via mitigation has been slow, and it has been complicated by political and economic positioning. Inevitably, while mitigation solutions evolve, the earth's climate will keep on changing and impacting the vulnerable. Thus, adaptation efforts are needed to aid in making adjustments to inevitably new climatic conditions.

industrial processes or electricity generation, or switching to renewable energy such as solar energy or wind power. Re-planting forests or creating new ones is a good example of increasing carbon sinks, i.e., sequestering greater amounts of carbon dioxide (CO_2).

Climate Change Adaptation is understood as the things we do, planned or not planned (autonomous), that result in adjustments to climate-induced hazards. Adaptations are considered to be adjustments in natural or human systems in response to actual/expected effects of climate change. These adjustments are intended either to reduce the harm caused by these effects or to take advantage of opportunities that climate change may present, e.g., adaptation funding. Adaptation activities can be proactive (before the effects of climate change are felt) or reactive (after the effects). They can also be planned and implemented, by public and private actors, or happen autonomously.

Box 3. Adaptation vs. Resilience Building

The simplest way to understand the difference between adaptation and resilience building is to look at 'adaptation' as the 'what to do' to lower vulnerability to climate change, for example, increasing household water storage capacity. Resilience building can be looked at as the 'how to' design and or deliver the adaptation to bring forward development value in the context of systems, community, and/or society, e.g., establishing a community managed emergency water storage facility. There are six (6) key characteristic to the 'how to' to consider: 1) scale; 2) robustness; 3) rapidity; 4) redundancy; 5) flexibility; and 6) self-organization. (*see Annexure II*)

Hazard Events in terms of 'climate change', a hazard event is a potential event caused by a climate condition that causes loss of life, and or damage to property, environment, livelihood, and or human dignity. Most common climate-related hazards include changes in rainfall patterns resulting in drought and flood events, severe weather-related storms resulting in property and or crop losses, to changes in biodiversity within an ecosystem, e.g., loss of species, and/or pest infestations resulting in the loss of ecosystem services.

Climate Vulnerability: Vulnerability is considered as the degree to which physical structures, people, or natural and economic assets are exposed to loss, injury or damage caused by the impact of a hazard. In case of climate vulnerability, it is broken down into three constituents in direct relation to climate hazards:

- the degree of exposure to climate related hazards;
- the degree of capacity available to deal with climate related hazards; and
- the degree of sensitivity to the given climate related hazard.

Adaptive Capacity refers to individual and or collective strength and resources that can be accessed to allow individuals and communities to reduce their vulnerability to the impact of hazards. These capacities can either prevent or mitigate the impact of a given hazard, or prepare the community to respond to the impact better (readiness).

Resilience refers to the capacity of a system, community or society potentially exposed to hazards to adapt via either resisting or changing in order to reach and maintain an acceptable level of function and structure. This is often determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters in order to improve risk reduction measures.

Resilience adds a time dimension to the concept of vulnerability: a system is resilient when it is less vulnerable to shocks across time and can recover from them in a timely manner (Figure 4). Resilience is achieved through exposure and sensitivity reduction and increased adaptive capacity. These can be undertaken across biophysical, economic or social domains. An example would be the transport of feed in case of drought or safety nets to compensate for bad harvests. Resilience puts great emphasis on the capacity of a system to recover and transform itself in the long term. In order to adapt to the changing environment, the system itself needs to take action at multiple levels, in various dimensions: ecological, technical, economic and social,l as well as involving various categories of actors and enabling governance environments. Additionally, different time frames need to be integrated for specific actions to produce positive effects.

Climate smart agriculture is not a new agricultural system, nor is it a set of practices. It is a new approach, a way to guide the needed changes in agricultural systems, given the need to jointly address food security and climate change (Grainger-Jones 2011). This section aims at clarifying how CSA relates to some other approaches.

*If a family grows rice in a valley bottom that is starting to have higher floods that submerge their rice plants every 3 to 4 years for the first time in memory, the farm's **exposure** to climate change damages is increasing, resulting in yields that in flood years are less than half of past yields. Most rice varieties will die if completely submerged for more than a few days, as they are **sensitive** to deep flooding. When you recommend that the family adopt a new rice variety that can tolerate being submerged, the family can reduce its **sensitivity** to the new pattern of flooding. Your knowledge and work with the family has increased its **adaptation** to the changing conditions.*

Three elements contribute to the vulnerability of farm livelihoods:

Vulnerability = (Exposure x Sensitivity) – Adaptive Capacity

In other words, the vulnerability of a farming system is the result of its exposure to climate change risks multiplied by its sensitivity to those risks, minus its capacity to adapt to climate change (Figure 3).

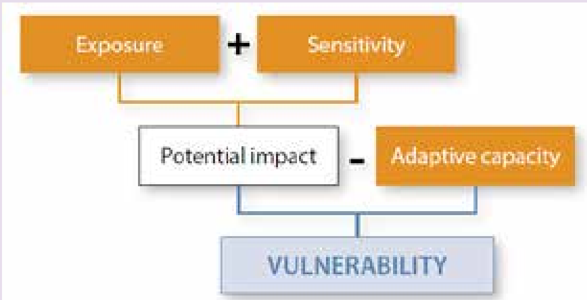


Figure 3: IPCC-derived conceptual model of vulnerability

Source: *McCarthy et al. 2001*

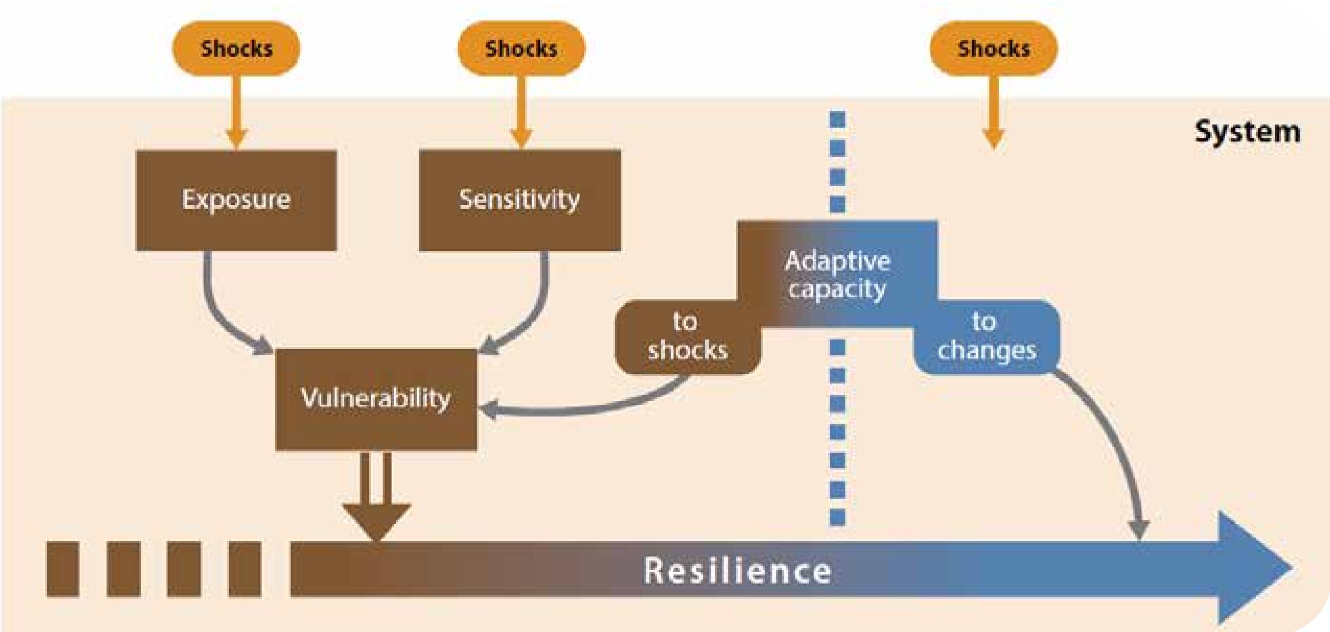


Figure 4: Vulnerability and resilience

Source: *Meybeck and Gitz 2012*

Example: Climate change adaptation

Consider a coastal fishing village. Hurricanes occur seasonally. Air and sea temperatures, as well as intense rain events are increasing. Certain fish populations have declined in recent years. Most households are involved in fishing and bring their catch to a nearby port for sale without the use of refrigeration. Some households are also involved in small-scale farming. Some homes are constructed further inland while others are built along a small river bank. Some homes are constructed on stilts. Basic wells provide access to groundwater.



Systems of interest	***Hazards/ Climate signals***	***Potential impacts***	
The village could be the system of interest, made up of key assets (boats, homes, wells), and port infrastructure; and resources (fisheries, groundwater, and arable land).	*Sea level rise, hurricanes, intense rainfall, increasing air and sea temperatures*	*Flooding, storm damages to assets, freshwater pollution, decline in fish stocks, saline intrusion into groundwater*	
Exposure	***Adaptive capacity / Sensitivity factors***	***Vulnerability***	***Adaptation***
There is a likelihood that all households are exposed to hurricanes and contamination of groundwater along with saline contamination of groundwater. Settlements on the shore and at the mouth of the river are particularly exposed to storm surge. Fishing households are exposed to declines in fish stocks associated with changes in ocean conditions as well as to potential impacts on the port. Farming households are exposed to the salinization or erosion of arable land.	*Fishing economies are sensitive to increasing temperatures due to the lack of refrigeration. Households involved in both farming and fishing have a greater adaptive capacity than other households to potential impacts. Houses on stilts are less sensitive to flooding than other households. Households with access to a car or motorcycle have a greater adaptive capacity to evacuate in the case of hurricanes or landslides.*	*This village is highly vulnerable to climate change impacts. Households depending on a single source of income, in exposed, non-stilt housing and without access to transportation, are most vulnerable.*	*Vulnerability could be reduced, for example, by setting up natural or physical infrastructure to protect settlements and arable land from storm surges, evacuation planning or the construction of shelters in the event of hurricanes, improving fish storage, enhancing construction standards and by improving freshwater resources, either through treatment or surface water access.*

Source: *GIZ 2011*

VIDEO

Let us see a short animated film on Climate Change Adaptation

We know enough about climate change: It's time for decisions now! *(5:42 minutes).*

The film explains climate change and its consequences, introduces adaptation and illustrates adaptation options. It advocatesthe a participatory approach to adaptation planning and highlights the benefits of timely action rather than delaying decisions.

The film can be presented after introducing the participants to basic concepts of climate change. GIZ and the Potsdam Institute for Climate Impact Research jointly developed the animated short film. It can be viewed at AdaptationCommunity.net.

VIDEO

Let's see a short video on ***Understanding Climate Smart Agriculture*** *by FAO. (2:46 minutes)*

(Available at https://www.youtube.com/watch?v=lUdNMsVDIZ0)

This can be presented at the introductory session of CSA. This video explains the climate-smart agriculture approach including its objectives and why it is needed. Climate change will hit farmers, herders and fishers the hardest. The climate smart agriculture approach promotes the development of the technical, policy and investment conditions to achieve sustainable agricultural development for food security under a changing climate. It seeks to: increase sustainable agricultural productivity and incomes, help adapt and build resilience to climate change impacts, and wherever possible, reduce and/or remove greenhouse gases. To make climate-smart agriculture a reality we need to: expand the evidence base, improve policies, empower local institutions, and combine new financing options. Let's make sure our agriculture is productive and sustainable for generations to come.

What is Climate Smart Agriculture (CSA)?

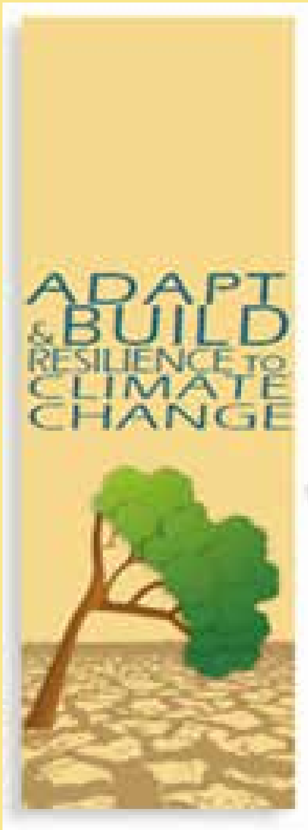
Climate smart agriculture (CSA), as defined and presented by FAO at the Hague Conference on Agriculture, Food Security and Climate Change in 2010, contributes to the achievement of sustainable development goals. It integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate change challenges. It is composed of three main pillars:

Elements of Climate Smart Agriculture

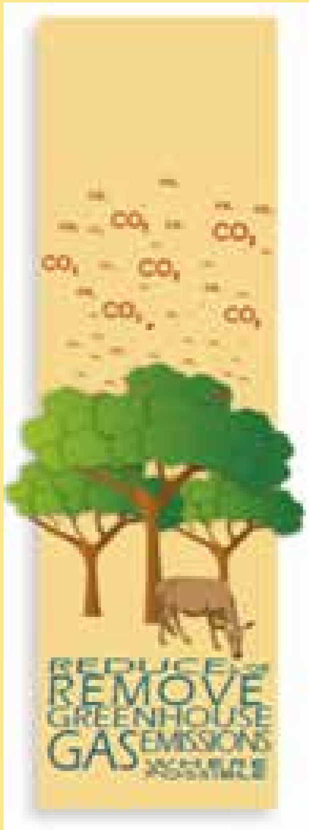
CSA is not a set of practices that can be universally applied, but rather an approach that involves different elements embedded in local contexts. CSA relates to actions, both on-farm and beyond the farm, and incorporates technologies, policies, institutions and investment. Different elements which can be integrated into climate smart agricultural approaches (CCAFS and FAO 2014) 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 vital, and to simultaneously increase resource efficiency and resilience;
- Services for farmers and land managers to enable them to implement the necessary changes.

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



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.



Wherever and whenever possible, CSA should help to reduce and/ or remove greenhouse gas (GHG) emissions. This implies that we reduce emissions for each calorie or kilo of food, fibre and fuel that we produce. That we avoid deforestation from agriculture. And that we manage soils and trees in ways that maximizes their potential to acts as carbon sinks and absorb CO2 from the atmosphere.

Source: *FAO, 2018*

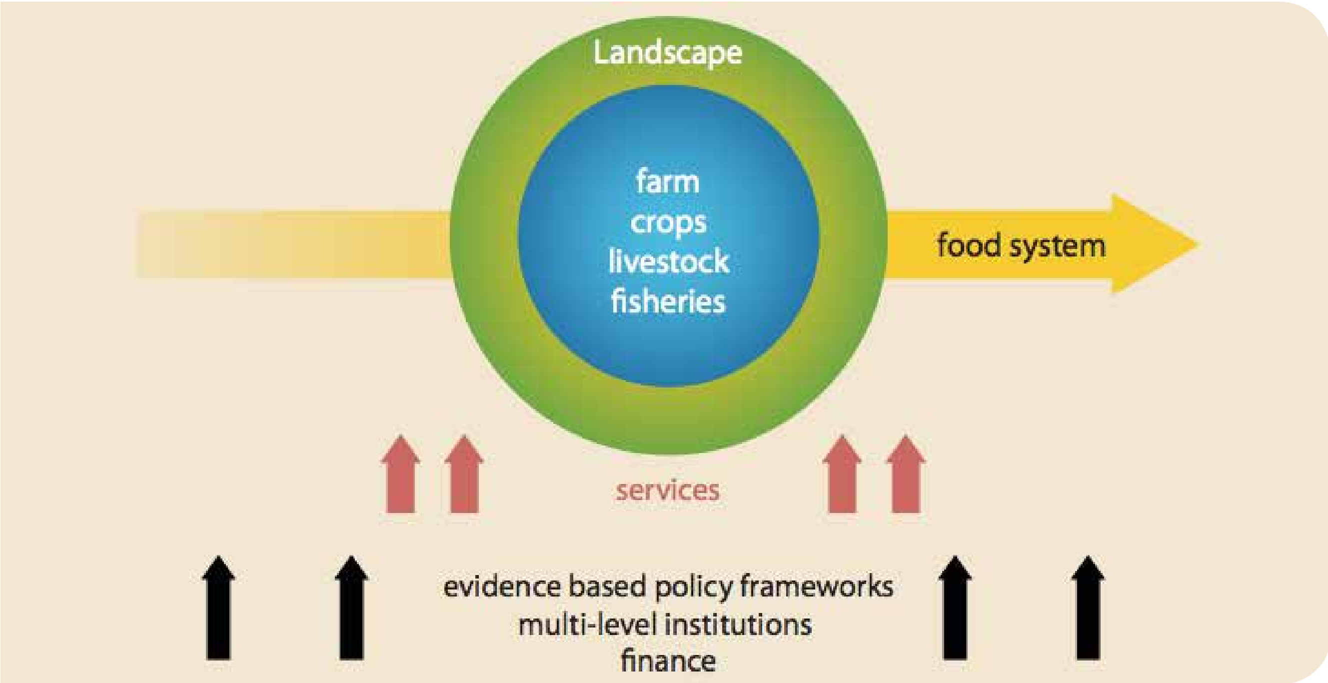


Figure 5: Elements of Climate Smart Agriculture

Box 4. Interview: Sonali Bisht -Climate-smart agriculture not an option, it is a necessity

Sonali Bisht, founder and advisor to the Institute of Himalayan Environmental Research and Education, an institute dedicated to sustainable development in the Himalayas, talks about how climate-smart agriculture can conserve soil health and make judicious use of resources.

What are the best ways to reduce greenhouse gas emissions associated with agriculture?

The best ways to reduce them is to produce and consume (food) locally as much as possible (and) cut down on distances involved in travelling. Ecological and organic agriculture use on-farm and natural inputs and do not use chemicals produced in factories. Reusing of agricultural wastes rather than incineration also reduces greenhouse gases. We also have the technology to use livestock emissions in productive ways.

How does the concept of climate smart agriculture deal with the following problems: degradation of farmlands, increasing competition for land and water, stagnation in growth of cereal yields, and impacts of higher temperatures, droughts and flooding?

Climate smart agriculture would ideally invest in and promote innovative, adaptive farming communities working towards restoring and conserving soil health. (It will also) use land and water optimally, do seed selection (judicially), and adapt to uncertain weather conditions armed with the knowledge of options, choices and resources to use them.

In the present context of climate change, should we focus on producing more with less or should adaptation be the keyword? Do you think climate smart agriculture can deal with Asia's growing population pressure?

They are not mutually exclusive and agriculture is very site specific, so there cannot be universal solutions. Climate smart agriculture is not an option. It is a necessity now. The first pillar of climate-smart agriculture is productivity. Farmers need productivity, along with adaptation and mitigation efforts.

India has witnessed its worst droughts and floods for last few years. How will climate-smart agriculture help the country in managing its resources better?

Climate smart agriculture should create readiness to deal with extreme weather conditions and weather uncertainties, which are becoming the new normal. Management of resources cannot be left to governments. Every citizen and every farmer has a responsibility. Every climate smart farmer should incorporate practices like farm ponds, bundings, trenching, mulching and other practices for conservation of soil moisture, use appropriate seeds and on-farm inputs (to avoid debt situations), and to have better access and control over required resources.

Source: *Niyogi 2018*

Actions to Implement Climate Smart Agriculture

Governments and partners seeking to facilitate the implementation of CSA can undertake a range of actions to provide the foundation for effective CSA across agricultural systems, landscapes and food systems. CSA approaches include four major types of actions (CCAFS and FAO 2014):

- Expanding the evidence base and assessment tools to identify agricultural growth strategies for food security that integrate necessary adaptation and potential mitigation
- Building policy frameworks and consensus to support implementation at scale
- Strengthening national and local institutions to enable farmer management of climate risks and adoption of context-suitable agricultural practices, technologies and systems
- Enhancing financing options to support implementation, linking climate and agricultural finance

Is Climate Smart Agriculture Different from Current Agriculture?

Both current agricultural practices and climate smart agriculture are context-specific. What is practiced in India may not be practiced in the United States. To identify climate smart alternatives we need to look at specific farming systems. Remember that farming practices have various effects on the natural resource base, on the environment and on climate. Some conserve the environment and enable farmers to adapt to a changing climate; others do the opposite.

Can current agricultural practices be climate smart? Yes! As we see in this session, what makes one particular practice climate smart, rather than another one, is its final outcome.

Current Agriculture vs. Climate Smart Agriculture

Current agriculture: *Governments, extension services and agricultural development projects increase agricultural output and productivity by expanding the cultivated area, introducing new farming technologies, and encouraging farmers to specialize in certain crops or livestock breeds.*

Climate smart agriculture: *Interventions are aimed at increasing output and productivity, thus improving food security, but it has two additional aims: to help farmers adapt to climate change, and to reduce the level of greenhouse gases in the atmosphere.*

Table 1: Comparing Current Agricultural Practices and Climate Smart Agriculture

Resources/Services	Current agricultural practices	Climate-smart agriculture
Land	Expand agricultural area through deforestation and converting grasslands to cropland.	Intensify use of existing areas rather than expanding to new areas; Expand the area cultivated by restoring degraded land rather than deforesting new areas.
Natural resources	Make the most use of natural resources – land, water, forests, and soils used in production – without paying much attention to their sustainability over the long term.	Restore, conserve and use natural resources sustainably.
Varieties and breeds	Rely on a few crops and/or a few high yielding varieties and breeds.	Use a mix of traditional and modern, locally adapted varieties and breeds to maintain output, increase yields, and ensure their stability in the face of climate change.
Inputs	Increase use of fertilizer, pesticides and herbicides.	Improve efficiency of agrochemical use; Control pests and weeds using integrated management approaches; Apply compost, manure and green manure; Rotate crops with legumes to fix nitrogen and reduce use of artificial fertilizers.
Energy use	Use farm machinery that usually relies on fossil fuels – such as tractors and diesel pumps.	Use energy-efficient methods, such as solar power and biofuels.
Production and marketing	Specialize production and marketing to achieve greater efficiency.	Diversify production and marketing to add stability and reduce risk.

Source: *FAO 2013*

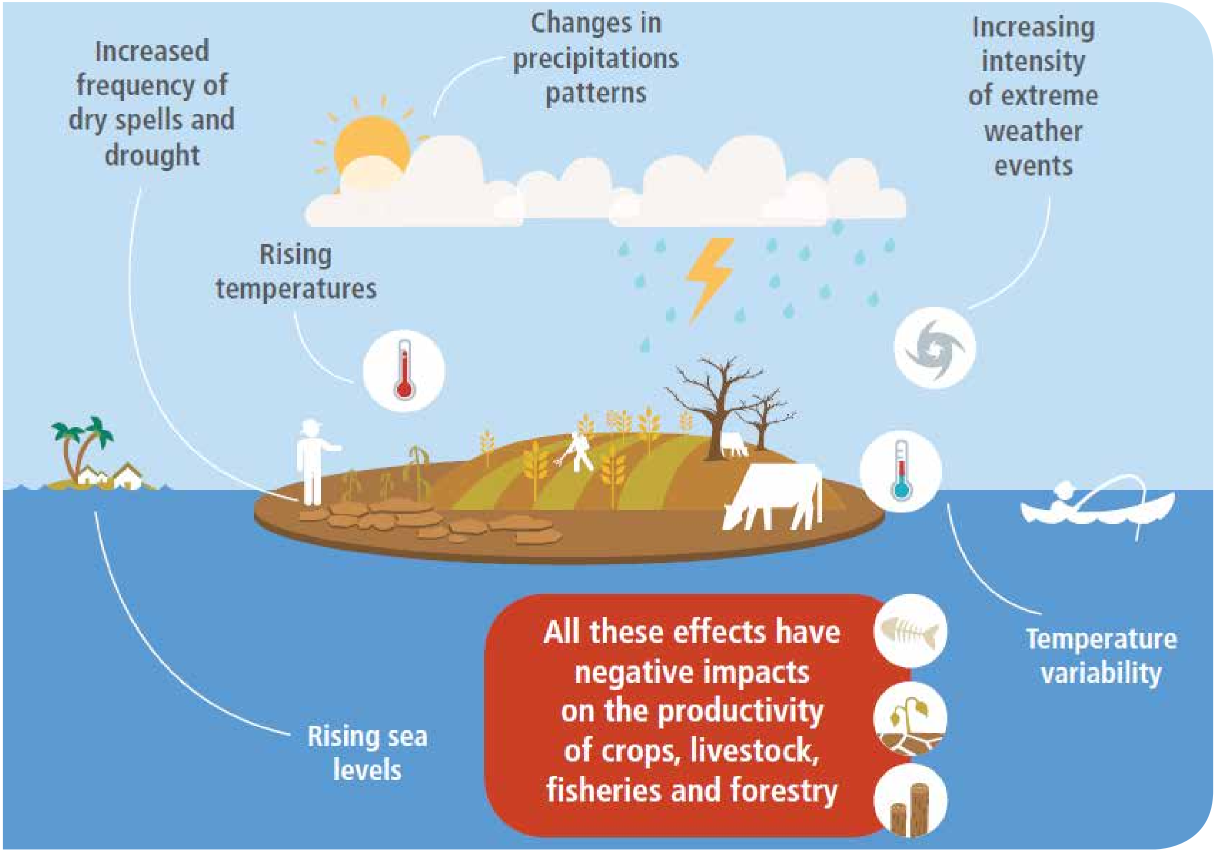


Figure 6: Impact of climate change on agriculture

Source: *FAO 2016*

Why Climate Smart Agriculture (CSA)?

Climate change is emerging as a major threat to agriculture, food security, and livelihood of millions of people in many parts of the world (IPCC 2014). Climate change is already negatively impacting agricultural production globally and locally. FAO estimates that feeding the world's population will require a 60% 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 the 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 aim to identify and prioritize locally appropriate climate smart agriculture technologies which will address a number of context-specific multi-dimensional challenges in agricultural systems.

CSA is an approach to developing the technical, policy and investment conditions so as to achieve sustainable agricultural development for food security under the climate change scenario. The magnitude, immediacy, and broad scope of the effects of climate change on agricultural systems create a compelling need to ensure comprehensive integration of these effects into national agricultural planning, investments and programmes.

CSA - An Interdisciplinary Approach!!

CSA is not a single specific agricultural technology or practice that can be universally applied. It is an approach that requires site-specific assessments to identify suitable agricultural production technologies and practices. This approach:

- Addresses the complex interrelated challenges of food security, development and climate change; and
- Identifies integrated options that create synergies and benefits and reduce trade-offs;
- Recognizes that these options will be shaped by specific country contexts and capacities and by the particular social, economic, and environmental situation where it will be applied;
- Assesses the interactions between sectors and the needs of different involved stakeholders;
- Identifies barriers to adoption, especially among farmers, and provides appropriate solutions in terms of policies, strategies, actions and incentives;

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).

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).

CSA addresses the relation between climate change and agriculture

- 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. 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.

Figure 7: CSA and relationship between poverty, food security and agriculture

Source: *Saravanan et al. 2018*

- Seeks to create enabling environments through a greater alignment of policies, financial investments and institutional arrangements;
- Strives to achieve multiple objectives with the understanding that priorities need to be set and collective decisions made on different benefits and trade-offs;
- Should prioritize the strengthening of livelihoods, especially those of smallholders, by improving access to services, knowledge, resources (including genetic resources), financial products and markets;
- Addresses adaptation and builds resilience to shocks, especially those related to climate change, as the magnitude of the impacts of climate change has major implications for agricultural and rural development;
- Considers climate change mitigation as a potential secondary co-benefit, especially in low-income, agriculture-based populations; and
- Seeks to identify opportunities to access climate-related financing and integrate it with traditional sources of agricultural investment finance.

This does not mean that every agricultural practice should achieve all the three objectives. Rather, climate-smart agriculture seeks to re-orient agriculture by taking these objectives into consideration and informing farmers' decisions. It is an interdisciplinary approach that is not limited to a single set of practices. Its application is tailored to specific situations using information from many sources. It requires comprehensive capacity development efforts at various levels to promote behavioural changes and to enhance institutional and political settings, while strengthening organizations and institutions and building the individual capacities of various stakeholders. Since it focuses on broader social and ecological outcomes it requires the participation of both farming communities and decision-makers and an understanding of the synergies and trade-offs. National priorities need to be set according to each country's social and economic characteristics, ongoing development processes, and natural resource availability.

Climate smart agriculture is site-specific rather than a universal approach. What can be defined as 'climate smart' in one location may not be smart in another context. Climate smart agriculture therefore is strongly evidence-based with the aim of identifying practices that are appropriate to the local context. This base is rooted in a process of building knowledge and dialogue on the technologies and practices that a specific country has prioritized in its agricultural planning. In this framework, information on projected climate change trends is collected to assess food security in future years as well as to customize according to the adaptation potential of selected technologies and practices under changing climatic conditions (FAO 2013).

Conclusion

Extension officers are expected to provide and disseminate information to farmers. Under the threat of increased greenhouse gases which results in high temperatures and uncertainty in rainfall, there is a critical need to communicate climate change scenarios, adaptation and mitigation strategies to all stakeholders, particularly farmers. For this, agricultural extension personnel need to be well-equipped with adequate knowledge to enhance resilience and to reduce greenhouse gas emissions. This unit focused on how to help extension personnel brush up basic terms and concepts related to CSA.

Exercises

Exercise 1

What is climate and weather?

Review the definitions of climate and weather in the manual in the manual and also review the examples.

1. Ask for volunteers to describe the weather in their area.
   - What is the weather like today?
   - What season is this and what is the weather like in this season?
2. Ask participants to describe the main characteristics of their climate.
   - How many seasons are there each year?
   - What is the average temperature in the area?

Exercise 2

What are the signs and effects of climate change in my community?

1. Divide the participants into small groups.
2. Provide each group with paper and a marker.
3. Ask participants to:
   - Make a list of any signs of climate change or climate variability that they are experiencing in their community.
   - Describe how these changes are affecting agricultural activities/farm families/livelihood.
   - Invite the groups to share the results of their discussions with the large group.
   - Discuss changes and impacts that were mentioned by all the groups.

What are the extreme events affecting region or community?

1. Ask about recent extreme events such as hurricanes, flood, droughts, landslides, volcanic eruptions, storms, and forest fires in their region/communities.
   - What was the damage?
   - How often do natural disasters' impacts affect their region/communities?
   - Are people prepared for these events?
   - Does the region/community have an early warning system?
2. What are some of the issues that contribute to local and regional impacts?
3. Discuss how communities can manage these extreme events.

Exercise 3

Adaptation and Mitigation

1. Divide the participants into groups. Ask each group to imagine they are in one of these hazardous situations:
   - The soil on your main farming field is degrading a bit more every year. Your crop yield is declining.
   - A pest is attacking your crop. You are afraid that as much as 80% of the harvest will be lost if you do not intervene.
   - It's been raining heavily for days. Your crop field is flooded, and you estimate that it will remain submerged for at least two weeks.
   - You planted all your cropland with rice this year. When the harvest season comes the price for rice has fallen by 60% and your household income is at risk.

2. Ask each group to discuss:
What could you have done to avoid the situation in the first place?
   - What can you do now to prevent the problem from getting worse?
   - If the problem does get worse, what can you do to reduce the damage caused?
3. Ask the participants to think of ways that agricultural producers, and others involved in agriculture, can adapt to climate change and what governments can do to encourage adaptation and mitigation. What can the extension service and extension agents do?

Exercise 4

Climate Smart Agriculture

1. Explain the concept of climate smart agriculture and its three objectives: Food security, Adaptation, and Mitigation.
   - Ask the participants to think of examples from their own experience of the three approaches to adaptation: reduce exposure, reduce sensitivity and increase adaptive capacity.
   - Ask them to think of examples of the two approaches to mitigation: reduce greenhouse gas emissions and increase sequestration of carbon in above ground vegetation and in below ground soil.
   - Ask them what practices have proved useful in increasing food quality and quantity despite climate change.

Exercise 5

Current Agricultural Practices vs. Climate-Smart Agriculture

1. Ask the participants to identify several major types of farming that are common in the region.
2. For each system, ask them to identify whether it:
   - Contributes to improving food security;
   - Helps agricultural producers adapt to climate change;
   - Contributes to mitigating climate change.
3. Ask the participants to justify the reasons for their identifications.
4. On a flip chart, draw a three-circle diagram of three objectives of CSA. Ask the participants to indicate into which circle of the diagram can each of the current agricultural practices go.
5. Facilitate a discussion on which is the best practice from a climate smart point of view.
6. Ask the participants to suggest how each of the practices might be changed to help it meet two or even three of the climate smart objectives.
7. Ask them to think of other practices that they would regard as climate smart. Make a list of these practices on a flip chart.

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Unit III:
Role of EAS in Promoting CSA

Objectives

- Elucidate the role of EAS in promoting CSA;
- Explore challenges faced by EAS in supporting CSA.

Introduction

Climate change is already happening. It has started affecting agriculture and food security. Extension personnel need to be confident to communicate change information to producers, given their strong relationships with producers, and promote adaptive management practices for immediate use on farms. If Extension and Advisory Services (EAS) need to support farmers in addressing climate change concerns, their capacities need to be significantly enhanced. Knowledge, attitudes and skills acquired by the extension agents on climate change are expected to be explored and utilized through effective dissemination of climate smart agricultural initiatives to the farmers for sustainable agriculture and rural development (Oladele and Tekana 2010). Successful extension services delivery on climate change resilience is therefore critically dependent on the involvement of extension personnel in the dissemination of information to farmers, most particularly on climate smart agricultural initiatives. There is no category of intermediaries other than EAS that have an explicit focus on supporting such change among rural communities. This unit explored the role played by Extension and Advisory Services (EAS) in linking farmers with sources of new information and tools so that they can transition to CSA practices.

Discussion

EAS in promoting climate smart agriculture practices

EAS is collectively comprised of several types of providers who can be grouped under a number of different terms, including extension agents, community knowledge workers, agronomists, facilitators, advisors, promoters, knowledge intermediaries, and programme managers. These providers deliver a range of services and provide technical, organizational, entrepreneurial and managerial support to rural/agricultural communities.

Promoting climate smart agriculture involves changing the behaviour, strategies and agricultural practices of millions of agricultural producers. These producers need to be supported in understanding the impacts of climate change and adopting more climate smart strategies. EAS are able to effectively support the promotion of climate smart agriculture among farmers for a number of reasons (FAO 2013).

- RAS staff have close working relationships with rural communities, especially at the field level. Farmers will be more receptive and willing to experiment with advice related to climate smart agriculture if supported by RAS.
- RAS providers often have a thorough understanding of farmers' vulnerabilities and the

> *The Global Forum for Rural Advisory Services (GFRAS) defines EAS/RAS as consisting of all the different activities that provide the information and services needed and demanded by farmers and other actors in rural settings to assist them in developing their own technical, organisational, and management skills and practices so as to improve their livelihoods and well-being*
>
> ***Source:** Christoplos, 2010*

prevailing conditions under which they operate. Their understanding extends to the assets of farm households, the social dynamics within and between communities, and farmers' adaptive capacities.

- RAS providers are often aware of the support and services available locally, and the different types of user groups.
- RAS providers can play the needed mediation role for the extensive scaling up of climate smart agriculture. Their expertise in mediation will be useful for supporting wider interactions among these different stakeholders, including those in the private sector to support promotion of climate smart agriculture.
- During and after natural disasters and extreme weather events, RAS often assist rural communities in coping with the crises by providing relief and engaging in rebuilding rural livelihoods post-disaster (Shepherd et al. 2013).

How can RAS contribute in promoting climate-smart agriculture practices?

RAS use a number of approaches and tools to reach farmers with new knowledge, including: demonstrations, training activities, individual farm visits, the training of lead farmers or farmer trainers to train others, training of input and service providers, group discussions, exposure visits to innovative farmers Farmer Field Schools, plant clinics, field days, messages delivered through various media (e.g. mobile phone messaging, farm radio, participatory videos, television).

EAS can contribute to the following three objectives of climate-smart agriculture:

Sustainably increase agricultural productivity and incomes for food security

Climate smart agriculture to sustainably increase agricultural productivity and incomes involves testing, adapting and evaluating different technologies and management practices with farmers and other stakeholders. This is important for expanding the evidence base, determining which practices and extension methods are suitable in each context, and identifying the synergies and trade-offs between food security, adaption and mitigation (FAO 2016). EAS need to be well-placed to bring such information to farmers and coordinate information flows back to research activities.

Some of the traditional areas where EAS activities relate to key components of climate-smart agriculture:

- *Improved seeds and planting material, new crops and crop varieties and more efficient cropping systems;*
- *Sustainable mechanization (e.g., laser levellers, no-till seeders);*
- *Improved land management practices (e.g., terrace farming, soil and water conservation measures, furrow planting);*
- *Efficient and effective pest and nutrient management (e.g., integrated pest management, integrated nutrient management);*
- *Improved feed management practices (e.g., balanced rations);*
- *Post-harvest management and value addition activities;*
- *Organize and strengthen farmer groups (e.g., water user groups, producer cooperatives).*

Floating gardens is the climate-smart agriculture production system followed in Bangladesh where gardens are built on beds made of plant material and bamboo which remain intact despite the rise and fall of the river water levels, and it does not wash away no matter how long the floods last. ***(More details in Case 1 in the Cases section of this unit).***

Adapting to climate change

Actions to adapt to climate change can range from behavioural shifts (e.g. farmers planting more drought-resistant crops or more farmers buying crop insurance) to large-scale infrastructure projects (e.g., building coastal defences to protect against sea-level rise or setting aside land corridors to help species migrate). In many areas, successful adaptation to the impacts of climate change will require adjustments to existing systems (e.g., changes in crop management practices) and transformational changes (e.g., shifting to entirely different production systems). EAS play a crucial role in helping farmers to adjust to changing conditions and adapting to new practices. An important aspect of the support provided by EAS to farmers to help them adapt to climate risks is the delivery of climate information. EAS can use traditional media, such as radio, and new communication tools, such as mobile phones, to communicate climate information, including early

***Climate and crop modelling approach**, cropping advisories based on seasonal forecasts were developed to minimize farmers' risk in seasons with less rainfall. **Climate Smart Villages**, multi stakeholder innovation platforms, where researchers from national and international organisations, farmers' cooperatives, local government leaders, private sector organisations and key policy planners come together to identify climate smart agricultural interventions most appropriate to tackle the climate and agriculture challenges in the village.*

(More details in Case 2 and 3 in the Cases section of this unit).

The Suryashakti Kisan Yojana (SKY) is a subsidy scheme launched in June 2018 by the Government of Gujarat (GoG) in agriculture, to encourage farmers to give up their farm electricity connections and instead switch to solar-based power, which will be provided by a separate feeder. SKY also allows farmers to make more money by surrendering and selling their surplus energy to local utilities for 25 years under a power purchase agreement (PPA).

(More details in Case 4 in the Cases section of this unit).

warning weather advisories to farmers (FAO 2018). To identify and implement the most appropriate set of structural, physical, social and institutional climate change adaptation options, two major approaches are available: community-based and ecosystem-based (See Figure 8).

Reducing and/or removing greenhouse gas emissions for climate change mitigation

EAS contribute to climate change mitigation by promoting practices that increase the amount of soil organic carbon and/or reduce the relative rate of carbon dioxide released through the mineralization of soil organic carbon (e.g., returning organic matter to the soil as plant residues and manure). Other practices promoted by EAS that support climate change mitigation are those that optimize the use of external agrochemicals, such as pesticides and fertilizers that have a high carbon footprint (e.g., promoting integrated and ecological pest management) (FAO 2018). EAS can contribute to mitigation efforts, for example, by strengthening farmer groups and rural organizations in their efforts at implementing farming approaches and technologies that reduce emissions or sequester carbon as a co-benefit of increased productivity or climate change adaptation; supporting them in their efforts at accessing voluntary and regulated carbon markets; and promoting payment for ecosystem services programmes (David 2016).

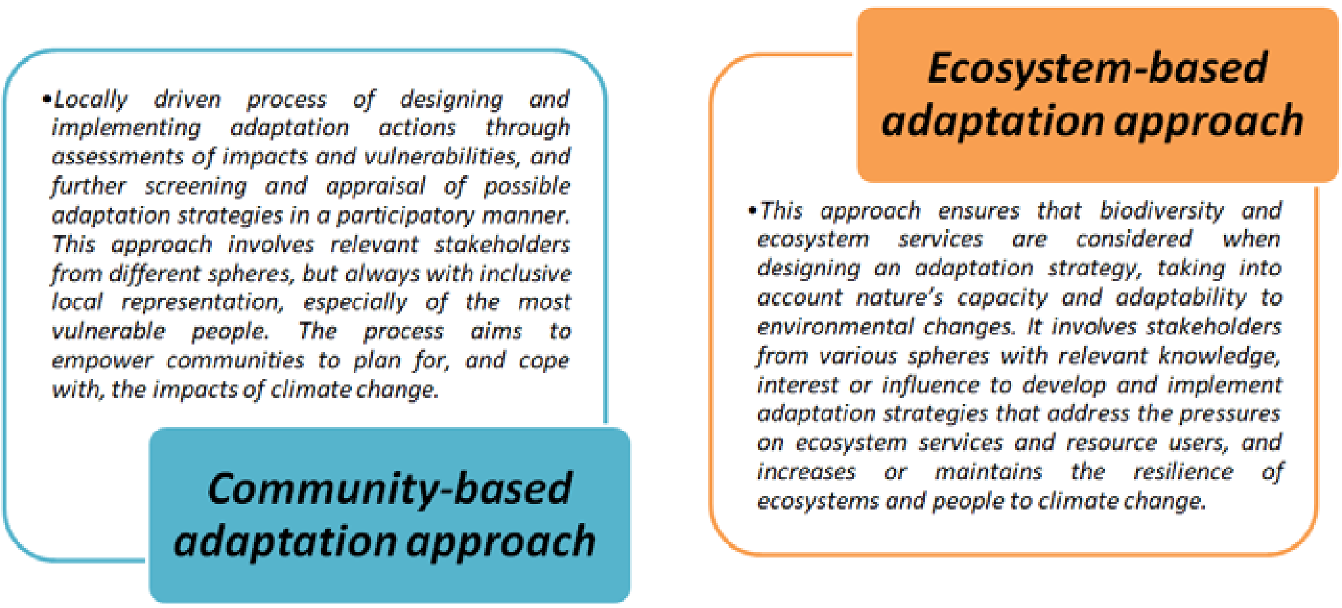

Figure 8: Climate change adaptation approaches

What could be the challenges EAS need to face to promote climate smart agriculture?

- Climate smart agriculture is a complex subject. Interventions need to rely on technically and functionally skilled facilitators. There is a need for continuous in-service capacity development for individuals, organizationsn and the people working within the broader enabling environment to support farmers.
- The results of some restoration measures or crop rotations might not be immediately visible to farmers. Maintaining the motivation of farmers and ensuring that benefits can be seen over different time spans is crucial.
- Addressing intertwined challenges of sustainable livelihoods, climate change adaptation and mitigation requires working across different geographic scales, from individual plots and farms to entire farming systems, landscapes or territories. This adds to the complexity of climate smart interventions.
- Implementing interventions in the field that address climate change at the community level often require multidisciplinary teams, with stakeholders who have diverse working methodologies, education and motivation. This can be a significant challenge in terms of human resources, institutions and policies that must be enabled to overcome, and to ensure lasting contributions are made to community resilience to climate change and sustainable livelihoods (FAO 2013).

RAS capacities to promote climate smart agriculture

- *Conduct local climate change impact and vulnerability assessments;*
- *Greater respect for indigenous and local knowledge;*
- *Stronger engagement with research;*
- *Organize a wider search for solutions;*
- *Expand the focus of RAS from households and farmer fields to the entire landscape.*

Source: *FAO, 2018*

Are the EAS equipped with the best set of capacities to promote CSA?

In the climate change context, there is a need to enhance the capacities of extension personnel enabling them to embrace and promote climate smart agriculture among farmers. So yes, the extension personnel need to develop new capacities and strengthen existing capacities.

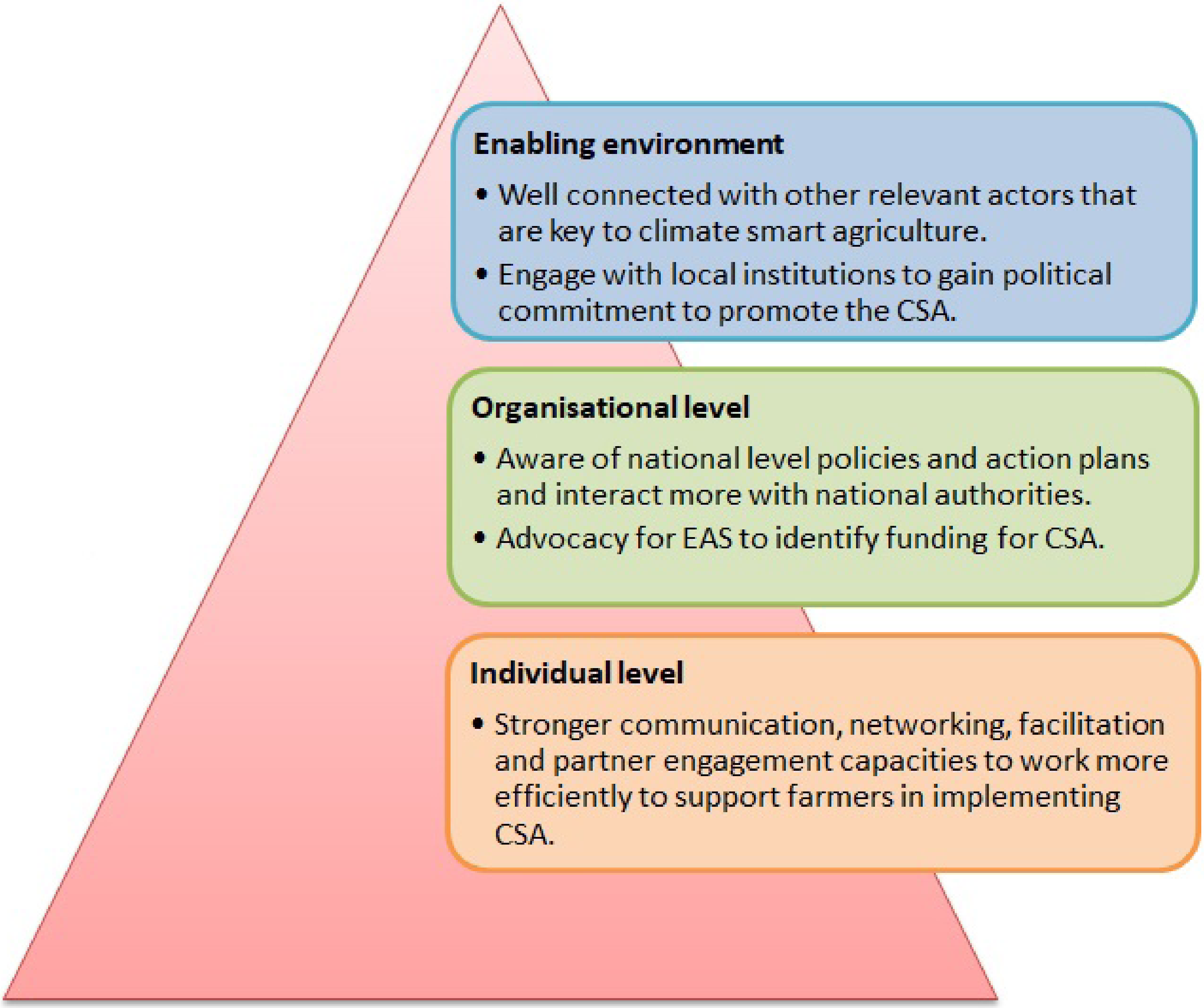

Figure 9: Capacities for EAS at different levels.

Source: *FAO 2017*

EAS personnel need to be well-informed about the nature of risks associated with climate change that farmers face in their area of activity, and should have the attitude and skills necessary to identify and promote appropriate CSA interventions among women and socially marginalized groups who are more vulnerable to climate change impacts (El Fattal 2012). Keeping in view the bridging and brokering role among organizations in different sectors that EAS staff should perform for promoting CSA, they need to re-orient their core expertise with regard to co-learning, sensitivity to gender and diversity issues, managing power and conflict dynamics, intermediation and facilitation (Sala et al. 2016). Considering the ever-evolving impacts of climate change, EAS managers need to develop long-term visions on their approach to climate change adaptation in agriculture (Muller et al. 2015). Personnel need expertise to undertake participatory scenario development and future visioning exercises by evaluating alternative scenarios (Palazzo et al. 2016), prioritising investments, contributing to policy formulation, and learning from policy and programme implementation (Lambol et al. 2011). The GFRAS has articulated the capacities that EAS need to develop at the individual, organizational and enabling environment levels (FAO 2012; GFRAS 2012) to effectively fulfil their role within CSA (Figure 9 and Table 2).

Conclusion

This unit focused on the role to be played by EAS in the climate change situation. It highlights the capacities extension personnel need in order to be well-equipped to embrace and promote climate smart agriculture among farmers.

Table 2: Individual and Organizational Level capacities of EAS to Support CSA

Individual level		Organizational level
Technical capacities	Functional capacities	
» Climate change and its direct and indirect effects on the agriculture sector and specific farming systems; » Climate smart agriculture principles and the synergies and potential trade-offs between adaptation, mitigation and food security; » The identification of climate change risks and assessing vulnerability; » Access to, and use of, agro-meteorological data to improve resilience and sustainability of farming systems; » Technologies and practices appropriate for promotion of climate smart agriculture; » Climate change adaptation options in agriculture, including technological, institutional and policy options; » Climate change mitigation options in agriculture, including the monitoring and assessment of greenhouse gas emissions; » Different mechanisms for risk management, including crop, animal and weather insurance; and » Different extension tools and approaches to promote climate smart agriculture.	» Participatory climate change adaptation planning; » Community mobilization and the development of farmer organizations for promoting climate smart agriculture; » Supporting producers and rural women to organize into different types of interest and activity groups; and » Sustaining and federating farmer organisations; » Facilitation – to encourage discussions, mediate conflicts, build consensus and foster joint action in multi-stakeholder processes; » Negotiation to help reach satisfactory compromises or agreements between individuals or groups, and increase the negotiating capacities among other stakeholders; » Ways of brokering and creating 'many-to-many' relationships among a wide range of stakeholders; » Networking and partnership development, including in areas where work is done in multi-organizational and multi-sectoral teams.	» The capacity to anticipate and respond to emergencies and organize support and services; » Enhanced financial resources and adequate human resources to effectively promote climate smart agriculture; » Systems for human resource development, which includes training infrastructure, appropriate curricula and well-trained faculty; » Information and communications technology and knowledge management infrastructure to enhance the flow of information among different stakeholders; » Strategic policy advocacy to forcefully articulate the impact of climate change on agriculture and the need for RAS to promote climate smart agriculture; and » Rules, norms and values that encourage collaboration among people working in different areas (e.g., research, agro-meteorological services, seed systems and the agricultural value chain), and promote sharing, interacting, and collective learning in the joint pursuit of climate smart solutions.

Cases

Case 1: Floating gardens: the Climate Smart Agriculture production system in Bangladesh

Bangladesh is prone to climate change with a build-up of heavy rains, frequent storms and rising sea levels that result in severe flooding. Due to continuous conditions of waterlogging, crops are often lost and land for agriculture has become scarce. The low-lying areas of the southern coastal and south central districts of Bangladesh remain submerged for 6–8 month periods every year, especially during the monsoon season. As a result, crop cultivation is not possible on land. Under these circumstances, location-specific adaptation and resilience measures with regard to climate change have become a priority for improving the food security of the nation's vulnerable people.

These farmers have converted the prolonged flooding season into an opportunity: 'floating gardens'. These are floating plots made from local organic material on which diversified vegetables are grown or seedlings are raised for marketing. Farmers prepare the rectangular-shaped beds during June and July and sow/transplant seeds eight to ten days after the last stacking to the garden bed. Around 30 species of vegetables, spices and other crops or seedlings are grown in this water-based production system. The major vegetable crops are okra, ribbed gourd, Indian spinach, brinjal, cucumber, red amaranth, stem amaranth, wax gourd and (in winter) turnip, papaya, cabbage, cauliflower, tomato and red amaranth. The spices turmeric and chili are also grown. Mixed intercropping is the most prevalent system.

Floating gardens have several advantages:

- The fallow waterlogged area can be cultivated and the total cultivable area is increased;
- The area under floating cultivation is more fertile than the land on plains;
- No (or minimal) fertilizer and manure are required, unlike the conventional agricultural system;
- After cultivation, the biomass generated can be used as organic fertilizer in the field and it conserves natural resources;
- During floods, floating gardens can be used as shelters for poultry and cattle. Fishers can cultivate crops and fish at the same time, since the gardens are built on beds made of plant material and bamboo. This allows the plot to rise and fall with the river water levels, and it does not wash away no matter how long the floods last.

Floating gardens are environmentally friendly, while contributing to food security and nutrition. The organic production of vegetables is important for local, urban and export markets. There is scope for improving productivity, profitability and marketing, as well as opportunities for value addition, through research and development programmes.

Source: *FAO 2018*

Case 2: Climate and crop modelling approach - Cropping advisories based on seasonal forecasts

A majority of the farming community in Hussainapuram, Kurnool, Andhra Pradesh, India, live below the poverty line. Over 50% of the cultivators hold less than two hectares of dryland. Twice in every five years the village experiences drought. Recurrent droughts force migration to nearby cities for employment. In this region the deep black soils are deficient in major and micro nutrients such as nitrogen, phosphorus, sulphur, boron and zinc. Cotton, groundnut, sunflower and chickpea are the major crops in the region. Cotton growers have been the worst hit by changing rainfall patterns.

2015 was an El Niño year and the forecasts were as follows: ▪ June: Normal onset and quantity of rainfall. ▪ July - August: Less than normal rain. ▪ September - October: More than normal rainfall. A rainfall pattern like this cannot sustain staple crops such as cotton and groundnut. Cotton grows for 150-165 days and needs 600 mm rainfall/irrigation from June to December, while groundnut grows for 105-110 days, needs 450 mm rainfall/irrigation and is sown anytime from mid-June to August.

Intervention

In view of the recurrent droughts the village faced (twice every five years), crop advisories were developed using the following approach to minimize farmers' risk in seasons with less rainfall.

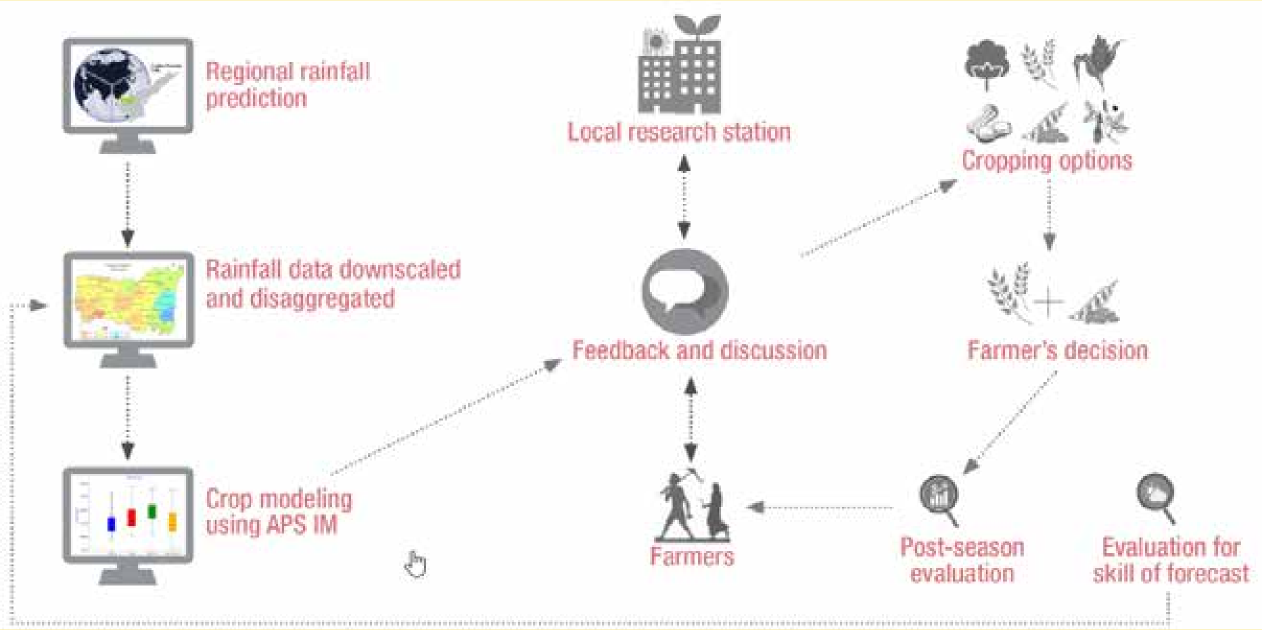

Figure 10: Crop Modelling Approach.

Regional rainfall prediction: The approach uses the Indian Institute of Tropical Meteorology (IITM) seasonal forecasts derived from Global Circulation Models (GCM) output and major ocean influences, and local weather patterns.

Rainfall data downscaled: The rainfall data is downscaled and disaggregated to multi-stational level by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Crop modelling using The Agricultural Production Systems Simulator (APSIM): Using the APSIM simulation model with inputs of historical weather and crop productivity data for 40 seasons, scenarios are assessed for various cropping options for the season. This is the third year ICRISAT has assessed scenarios for the project.

Feedback and discussion with farmers and researchers: The scenarios are shared with the local research station and farmers. Based on the feedback the best cropping options are arrived at. The cropping advisory is shared at a village meeting in the month of May based on which farmers take their individual cropping decisions.

Cropping decision options: Scientists advise farmers on what crops or combination of crops to grow and when to take up sowing. Farmers are also warned that the rainfall may not be sufficient to grow certain crops.

For the 2015 season, farmers were advised to intercrop short duration legumes like green gram (70 days), black gram (90 days) or a cereal like foxtail millet (90 days), with a longer season legume like medium duration pigeonpea (150 to 165 days), which matures when good soil moisture is expected in the season.

Impact: Farmers who followed the cropping advisory derived from climate and crop simulation modelling earned 20% more than those who did not heed the advice.

Future: The research has been extended to include some 150 farmers in Bijapur district, Karnataka, and more than 100 farmers in three other villages of Andhra Pradesh.

Evaluation: Post-season evaluation for value of forecast in terms of benefit to farmer was done and the results shared with the farming community to demonstrate the advantages of following weather-based crop advisories. Simultaneously the skill of forecasting is evaluated to ensure greater accuracy in the future.

Source: ICRISAT 2016

Case 3: Climate-Smart Villages: A Community Based Approach to Sustainable Agriculture, Haryana

The CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS) together with the International Maize and Wheat Improvement Center (CIMMYT) and National Agricultural Research and Extension System (NARES), CGIAR centres and farmer organisations are implementing the Climate Smart Village programme. Apart from South Asia, the programme is being piloted with a diverse range of partners in all CCAFS regions, that is, East and West Africa, Southeast Asia and Latin America. Climate-Smart Villages are sites where researchers from national and international organisations, farmers' cooperatives, local government leaders, private sector organisations and key policy planners come together to identify which mart agriculture interventions are most appropriate to tackle climate and agriculture challenges in the village. The idea is to integrate climate smart agriculture into village development plans, using local knowledge and expertise and supported by local institutions (Figure 11). There is no fixed package of interventions or a one-size-fits-all approach. The emphasis is on tailoring a portfolio of interventions that complement one another and suit the local conditions too.

Setting up a Climate-Smart Village

Figure 11: Components of a Climate Smart Village.

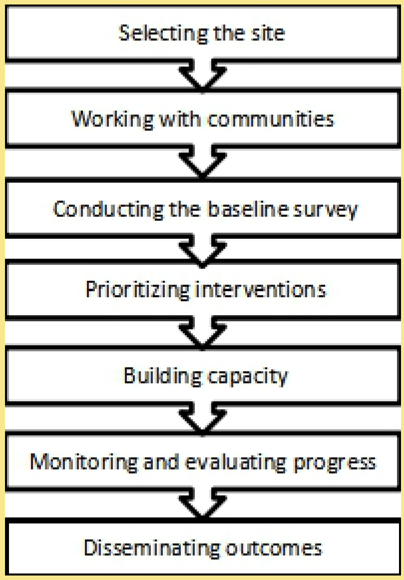

Figure 12: Steps in setting up a Climate Smart Village.

Key interventions in a Climate-Smart Village

The Climate-Smart Village adopts a portfolio of interventions that cover the full spectrum of farm activities. These include water smart practices, weather smart activities, nutrient smart practices, carbon and energy smart, and knowledge smart activities (Figure 12). These interventions work together to increase a community's resilience to climatic stresses while ensuring household food and livelihood security.

Figure 13: Key interventions in a Climate-Smart Village

In South Asia, Climate-Smart Villages were initiated in 2011, first in Haryana and Bihar in India and Rupandehi in Nepal. Here, we outline the status of Climate-Smart Villages in Haryana.

Climate-smart villages in Haryana

Haryana is an intensively cultivated semi-arid irrigated region with irrigation intensity exceeding 175%. It receives about 700 mm of rainfall annually. Rice-wheat is the predominant cropping system. The livestock and dairy industry is also an integral part of the rural economy of Haryana. Karnal district is the site of several pilot programmes by the government. It hosts important national research bodies, such as the Central Soil Salinity Research Institute (CSSRI), the National Dairy Research Institute (NDRI), Directorate of

Wheat Research (DWR), and the Regional Station of CCS Haryana Agricultural University. Under the aegis of National Initiative on Climate Resilient Agriculture (NICRA), a close partner of CCAFS-CIMMYT, these institutes are also implementing the Climate-Smart Village programme. At present, 27 Climate-Smart Villages are being piloted in Karnal. The villages are in Nilokheri, Indri, Gharaunda and Nissing blocks.

In intensive cereal-based systems, the success of alternative, efficient and climate resilient cropping systems depend on the resource endowments of the region and the full range of activities carried out by farm households. The selection of climate smart agriculture practices and technologies was based on the CCAFS Baseline Household Level Survey conducted in eight randomly selected villages (20 household per village) in Karnal district. The data gathered from this exercise was used to develop a farmer typology for developing the portfolio of climate smart practices and technologies for each block and village. From this survey, variables that were applicable to all farm households (i.e., where all farm households surveyed had an answer, either binary (yes/no) or continuous) were selected, based on their available resources, their livelihood activities and cropping practices. Village committees comprised of farmers, researchers and local planners were formed in consultation with the local community for prioritising and implementing key climate smart interventions relevant for the community – as different farmer typologies. Farmers' prioritisation and willingness to pay for climate smart agriculture technologies was also carried out through a select experiment by the International Food Policy Research Institute (IFPRI) and CIMMYT. The practices below are rated based on their Food Security (FS), Climate Risk Management (CR), Adaptation (A) and Mitigation (M) potential.

Table 3: Climate smart agriculture practice/technologies.

No.	Climate smart agriculture practice/technologies	FS	CR	A	M
1.	**Direct seeded rice:** Traditional rice cultivation involves sprouting rice in a nursery and then transplanting the seedlings into an intensively tilled field with standing water. With direct seeded rice, the rice seeds are sown directly in a dry seedbed just like any other upland crop. This eliminates the laborious process of manually transplanting seedlings, significantly reduces the crop's water requirements, and improves the soil's physical conditions.	x	xx	xxx	xx
2.	**Alternate wetting and drying in rice:** In alternate wetting and drying, rice fields are alternately flooded and drained. The use of a monitoring instrument such as a tensiometer can help farmers decide when to irrigate their fields. Alternate wetting and drying reduces methane emissions by an average of 48% compared to continuous flooding. Combining this with precision fertilizer tools can further reduce greenhouse gas emissions.	xx	x	xxx	xxx
3.	**ICT services to access weather and agro advisories:** M-Solution is a CCAFS-supported ICT-based climate and agro advisory project being piloted in Climate-Smart Villages by CIMMYT, together with Kisan Sanchar as the implementation partner and IFFCO Kisan Sanchar Limited (IKSL) as a content partner. Farmers get voice and text messages that inform them of weather forecasts, new seed varieties, climate smart farming practices and tips on conservation agriculture. The project aims to document farmers' perceptions on increasingly erratic weather events, and to understand if the information they receive helps in overall behaviour change towards adapting to climate change and in the uptake of new practices and technology. The project ensured the inclusion of women farmers right from the onset. Many farmers have said it is a vital source of information for them on climate change and agriculture.	xx	xxx	x	

4.	**Zero-tillage:** Zero-till or no-till farming is a way of growing crops without disturbing the soil through tillage. It increases the amount of water that infiltrates into the soil and increases organic matter retention and the cycling of nutrients in the soil. Zero-tillage improves soil properties, making it more resilient. A CCAFS-CIMMYT study comparing zero-tillage and conventional tillage in Haryana showed that zero-tillage provided both economic and climate gains. Results show that farmers can save approximately USD 79 per hectare in terms of total production costs and increase net revenue of about USD 97.5 per hectare under zero-tillage, compared to conventional tillage. The study shows that shifting from conventional tillage to zero-tillage based wheat production reduces greenhouse gas emissions by 1.5 Mg CO2 -eq per hectare per season (Aryal et al. 2014). Zero-tillage also helps in buffering from terminal heat effects, which is one of the key climate change-related constraints in wheat production in Haryana.	xx	xx	xxx	xx
5.	**Laser land levelling:** A laser leveller is a tractor-towed, laser-controlled device that achieves an exceptionally flat surface. Levelling the field ensures equitable reach and distribution of water and increases crop productivity. It also increases energy efficiency as less water means less need to run electric pumps. Most farmers in Haryana rent the equipment on an hourly basis. Farmers pay between INR 600-700/ an hour to use the machinery. The practice of laser land levelling has increased exponentially in the State. In Haryana, at the current adoption scale, the estimated amount of irrigation water saving is 933 million cubic meters per year. The estimated greenhouse gas mitigation is 163,600 MT of CO2 -eq per year (CIMMYT-CCAFS 2014).	xx	xx	xx	xxx
6.	**Residue management/mulching:** Crop residue mulching is a system of maintaining a protective cover of vegetative residues and stubble on the soil surface. It adds to soil organic matter, which improves the quality of the seedbed and increases the water infiltration and retention capacity of the soil. Rice crop residue burning is one of the major issues in Haryana. Using innovative planting machinery like the Turbo Happy Seeder, crops can be directly drilled without tillage while residue on surface acts as mulch.	xx	xx	xx	xxx
7.	**Crop diversification:** The aim of crop diversification is to increase farmers' crop portfolio so they are not dependent on a single crop for an income. This also diversifies a farmer's climate risk and contributes to increased household food security. Also, the innovative crop portfolio and system optimisation-based diversification options help in sustainable intensification. Introducing legumes into the crop rotation cycle helps fix Nitrogen in the soil.	xxx	xxx	x	x
8.	**Agroforestry:** Planting trees with crops or vegetables helps sequester carbon in the soil and prevents soil erosion. Trees provide shade to crops and are a source of timber, fruit, fodder and fuelwood for farmers. They enhance biodiversity by providing habitats to varied species of birds, insects and animals and contribute to a healthy ecological landscape.	x		xxx	xxx
9.	**Precision nutrient management:** Tools, such as Nutrient Expert Decision Support Tool, Leaf Colour Chart, and GreenSeeker sensors are used by farmers to determine optimum fertilizer dosage for crops and to assess crop vitality. Over-use of fertilizers increase production costs, damage the soil, contaminate groundwater and add to greenhouse gas emissions.	xxx		x	xxx

a.	**Nutrient Expert-decision** support tool helps farmers decide location-specific use of correct fertilizers in the hands of individual farmers. This site-specific nutrient management tool adds value to soil testing and guides farmers for precision prescriptions even in the absence of farmer access to soil testing. Nutrient Expert is an interactive software and is available on websites for free use.	xxx	x	xxx	
b.	**GreenSeeker** is a hand-held, easy to use crop sensor that can be easily calibrated locally. When held above the crop canopy, it calculates the Normalised Difference Vegetation Index (NDVI) which recommends the crop health and nitrogen requirement for a particular plot/field. Using GreenSeeker, farmers optimise the N fertilizer use to increase crop yield and profits as well as to reduce environmental footprints.	xxx		x	xxx
c.	**Leaf colour chart** is a visual chart used for measuring the greenness of the leaves to calculate the nitrogen to be applied to rice fields to get maximum productivity. It is also suitable for maize and wheat, and provides farmers with a good diagnostic tool for detecting nitrogen deficiency.	xxx		x	xxx

Note: xxx-high potential; xx-medium potential; x-reasonable potential

Scaling Out Climate-Smart Villages

Initial testimonials from farmers and policymakers indicate promising opportunities to scale out the Climate-Smart Village model and to mainstream climate smart agriculture into policies and development plans. By documenting the evidence on the synergies and trade-offs of a portfolio of climate smart agricultural interventions for a specific region, it is hoped that climate smart agriculture can prepare farmers to respond to the uncertainty that comes with climate change and its impacts on food security and livelihoods. Climate-Smart Agriculture Practices (CSAPs) are already prioritised and included in the agricultural plans of the State – for scaling-out these interventions with the aim of increasing agricultural productivity and farmers' incomes, while safeguarding the natural resource base from exploitation, and protecting biodiversity.

***Source:** CCAFS-CYMMIT 2014*

Case 4: Gujarat's Suryashakti Kisan Yojana (SKY) - An approach to integrate climate change in agriculture finance

Since the onset of the Green Revolution, India has increasingly relied on groundwater for irrigation. The government provides heavy subsidies to farmers for grid-based thermal power that boils down to almost free electricity, which serves as an irrational incentive, as it leads to overuse of both electricity and groundwater. Against this backdrop, increasing the deployment of solar pumps in agriculture offers a huge opportunity to address the complexities of the energy-water nexus in India, while also reducing the carbon intensity of the agriculture sector.

The Suryashakti Kisan Yojana (SKY) is a subsidy scheme launched in June 2018 by the Government of Gujarat (GoG) to augment the objective of the nation-wide KUSUM Scheme of promoting solar power in agriculture, and making the farmers self-reliant. The project plans to cover 33 districts of Gujarat, targeting almost 12,000 farmers who are currently using grid electricity for irrigation. The subsidy provided in SKY will be used to encourage farmers to give up their farm electricity connections and instead switch to solar-based power, which will be provided by a separate feeder. SKY also allows farmers to make more money by surrendering and selling the surplus energy to local utilities for 25 years under a power purchase agreement (PPA).

The SKY financial model SPICE consists of mainly four elements, viz., capital cost subsidy, sale of surplus electricity, resource conservation, and generation of renewable energy credits (RECs). Figure 14 shows how these elements have been integrated into the SKY financial model.

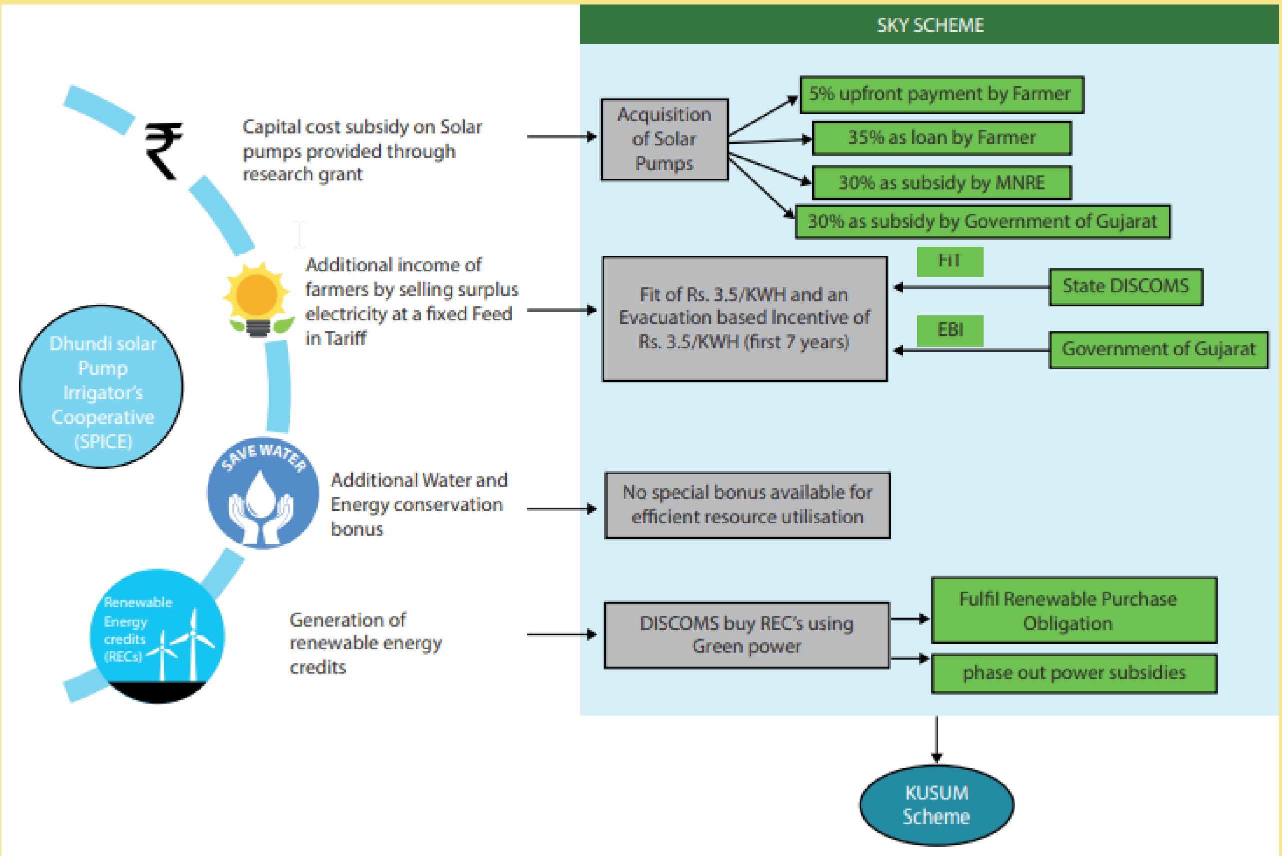

Figure 14: SKY financial model

Estimates from Gujarat Vij Corporation Limited (GVCL) show that about 14.8 lakh farmers are connected to the grid, with almost 27% of the electricity produced being supplied to them. The huge reliance on electricity leads to a variety of issues, such as a high carbon footprint, inefficient use of cheap electricity, and a low balance sheet for electricity distribution companies (DISCOMs) providing high farm power subsidies. To increase the penetration of solar pumps, the first milestone for SKY is to increase the maximum number of farmers on a given agriculture feeder. Various awareness campaigns are being organized to build a more robust model based on the feedback received from farmers on the issues they face. Once the necessary number of farmers are convinced, the second milestone will be to build these feeders in the targeted districts. As of now, two out of the five planned SKY feeders have been established in Rajkot district. Although the SKY scheme is still in its early implementation stage, its likely impact could be on the same lines as the Dhundi SPICE project.

Dhundi SPICE: Pilot Project: The IWMI-TATA Water Policy Research Program (ITP) conducted a small pilot in Dhundi village in Gujarat. ITP started the Dhundi Solar Pump Irrigators' Cooperative Enterprise (SPICE) pilot project in January 2016 with six farmers. Given the large upfront investment required for solar pumps that makes it unaffordable for farmers, the pilot model provided about 90% capital cost subsidy to make it a viable option. It also urged farmers to form a cooperative – SPICE, which would use solar power not only for irrigation but also to sell the surplus energy to Madhya Gujarat Vij Company Limited (MGVCL) under a 25-year power purchase agreement (PPA). The model has successfully enhanced the additional income of these six farmers as about INR 950,000 (USD 13754.8) was earned by SPICE by selling electricity upto August 2018. It lowered GHG emissions as the SPICE farmers consumed 46% less energy than average, while also making the farmers self-reliant by providing an affordable and reliable source of irrigation. Two elements of the model that make the pilot sustainable are: (i) the gradual phase down of capital cost subsidy by giving farmers an opportunity to sell excess electricity; and (ii) provision of sustainable incentive such as a Green Energy bonus and a Water Conservation bonus that encouraged the efficient use of energy and water, respectively. By December 2016, SPICE had added three more farmers and the subsidy was brought down further in the subsequent years.

The SKY financial model has the following elements that make it attractive, feasible, and sustainable:

Figure 15: Elements of the SKY model

Additional risk-free income generation stream: Solar energy can be termed as a 'remunerative crop' because it ensures a climate-proof and risk-free source of irrigation and also helps generate income for farmers. Farmers earn extra income, both by pooling excess green energy into the grid and selling irrigation services in local markets. This reduces their vulnerability to losses due to extreme climate-induced crop failure.

Improving financial viability of DISCOMs: The SKY model looks financially viable to DISCOMs due to its benefits of not just generating additional income but also saving the existing government-mandated expenses. Solar pumps will also provide an opportunity to phase down farm power subsidies provided by government and DISCOMs, thus reducing their burden.

Sustainable utilisation of resources: Provision of feed-in tariff (FiT) and evacuation based incentive (EBI) pushes farmers towards minimal and efficient utilization of groundwater and motivates them to eventually deploy energy-efficient pumps.

Reducing subsidy burden on the government: Solar pumps are currently promoted in India by providing huge capital cost subsidies ranging from 70% to 90% across states (Dekker 2015), which makes it fiscally unsustainable for the government. Selling green energy at an attractive FiT offers a great opportunity to phase down subsidy gradually by increasing the income of farmers.

Scale-up potential in India

Agriculture offers two major opportunities to promote adoption of solar pumps in India; high dependence on electric/diesel pumps and unreliable irrigation services due to climate vagaries, with only 48% of the country's net sown area receiving irrigation. A major push for solar irrigation in India came after the formulation of the Kisan Urja Suraksha evam Utthaan Mahabhiyan (KUSUM) in March 2018 by the Ministry of New and Renewable Energy (MNRE) that aims to install solar pumps, utilize the energy for irrigation, and sell the surplus to the DISCOM. Integrating the KUSUM scheme with existing state level subsidy schemes in Bihar, Rajasthan, and so on, can help kick-start this transformation.

Source: *Singh et al. 2019*

Exercises

Exercise 1

Role of Extension Staff

Divide the participants into three groups. Ask each group to take on one of the roles of the extension staff in the scenarios presented below.

Scenarios: Deciding on priorities

Raj is an extension agent working with villagers in a hilly area of the country. Over the years, the farmers have ploughed the soil on the slopes, causing severe erosion. Food is now scarce, and people have started abandoning their fields.

Remya is an extension agent working in a low-lying, coastal area. The mangroves along the coast have been cleared to make charcoal, and now the groundwater and water in canals are becoming salty as sea water forces its way inland. Newly introduced high-yielding rice varieties do not grow well, and yields are declining.

Akshay is an extension agent working in an area with large, mechanized farms. These are productive, but continuous cultivation is causing the soil to lose organic matter and fertility. Furthermore, the tractors and other machinery use a lot of fuel.

Ask each group to discuss what they would do to solve the problems described for their chosen extension staff member. What aspects of climate smart agriculture should they try to promote? What should the priority be: food security, adaptation or mitigation?

Invite each group to present the results of their discussion to the plenary. Facilitate a discussion for each presentation.

(Source: FAO 2018)

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Unit IV: Climate Change and Disaster Risk Management

Objectives

- Elucidate the relation between disaster, climate change and agriculture;
- Understand the contribution of EAS in disaster management.

Introduction

No one disaster is exactly the same as another, therefore impact and consequences vary from region to region and community to community. In developing countries, the agriculture sector attracts about 22% of the total damage and loss caused by natural hazards. A recent FAO study found that between 2006 and 2016, the agriculture sector absorbed approximately 23% of all damages and losses caused by natural hazard-induced disasters in developing countries (FAO 2018).

If not prevented, or significantly reduced or counteracted, these impacts will continue to have major negative implications for poverty and food security, worldwide (FAO, IFAD, UNICEF, WFP and WHO 2019).

In India, from 2001 to 2015, 33,291 human deaths were reported against 12,58,353 cattle heads lost, 1,97,35,686 houses damaged, and 581.50 lakh hectares of cropped area affected (GOI 2016). Farmers, including livestock owners, suffer during disasters in multiple ways.

Ideally, EAS being responsible for serving the farming community should be the primary stakeholders in helping out farming communities during disasters. It is well-known that many developing countries, including India, are not always well-prepared to deal with disasters. Lack of a well-developed disaster management plan leads to considerable loss of human life, animal life and property, which could be avoided if the necessary mechanisms were in place. A lot needs to be done to improve the situation, particularly with regard to livestock. Can we, as extension professionals, contribute meaningfully to better climate change and disaster management so as to minimize farmer suffering?

Discussion

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007) has collected reliable evidence to caution that extreme weather events and climate variability will increase the risks of natural disasters such as floods, flash floods and GLOFs (glacial lake outburst floods), cyclones, drought, sea level rise, coastal erosion, landslides, etc.

Climate change-related disasters have already seriously constrained development, and reduced food security, especially for households. The International Symposium on Agro-meteorology and Food Security organized in February 2008, in Hyderabad (Patel 2011), noted with concern that agricultural productivity has come down over a period of time. Growth of world agricultural output is expected to fall to 1.5% per year over the next three decades and further by 0.9% per year in the succeeding 20 years to 2050. Farmers will have to produce 40% more grain to meet the increasing global demand for cereals, when the world's population would be 7.5 billion by 2020. Climate change will manifest its different types of effects on crops and livestock, fisheries and aquaculture, land, water, biodiversity, and trans-boundary pests and diseases.

Disaster: A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

Disaster risk: The potential loss of life, injury, or destroyed/damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity.

Disaster risk management: The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies, and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster. This term is an extension of the more general term 'risk management' to address the specific issue of disaster risks. Disaster risk management aims to avoid or lessen the adverse effects of hazards through activities and measures for prevention, mitigation and preparedness.

Disaster risk reduction (DRR): The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Disaster response: An aggregate of decisions and measures to contain or mitigate the effects of a disastrous event to prevent any further loss of life and/or property, and restore order in its immediate aftermath.

Disaster relief: Collective actions carried out immediately after a disaster with the objective of saving lives, alleviating suffering, and reducing economic losses. For example, relief includes getting people to safe locations, provision of food and clothing, etc.

Disaster recovery: Recovery is the activity that returns humans and built infrastructures to minimum living/operating standards, and guides long term efforts designed to return life to normal levels after a disaster. This includes building temporary housing and provision of basic household amenities.

Disaster rebuilding: Rebuilding is the long term response to a disaster. In this phase, permanent infrastructures are rebuilt, ecosystems are restored, and livelihoods are rehabilitated.

Hazard: A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.

Preparedness: The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from the impacts of likely, imminent or current disasters.

Prevention: It refers to the complete avoidance of adverse impacts of hazards. Disaster prevention expresses the concept/intention to completely avoid potential adverse impacts through actions taken in advance. Examples include dams or embankments that eliminate flood risks, land-use regulations that do not permit any settlement in high risk zones, and seismic engineering designs that ensure the survival and function of a critical building in any likely earthquake. Very often the complete avoidance of losses is not feasible and the task transforms to that of mitigation. Partly for this reason, the terms prevention and mitigation are sometimes used interchangeably in casual use.

Resilience: The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.

Response: Actions taken directly before, during, or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

Mitigation: Mitigation refers to the lessening or limiting of the adverse impacts of hazards and related disasters. The adverse impacts of hazards often cannot be prevented fully, but their scale or severity can be lessened by various strategies and actions. Mitigation measures encompass engineering techniques and hazard-resistant construction as well as improved environmental policies and public awareness. It should be noted that in climate change policy, 'mitigation' is defined differently, being the term used for the reduction of greenhouse gas emissions that are the source of climate change.

Source: *UNDRR 2019*

How Climate Change is Intensifying Disasters in India (DMD & UNDP 2017)

There is considerable evidence that economic damage caused by extreme weather events has increased substantially over the last few decades. For a country such as India, with over 70% of its population relying directly or indirectly on agriculture for their livelihoods, the impact of extreme weather events is critical. People often live in areas of high ecological vulnerability and relatively low levels of resource productivity and have limited and insecure rights over productive natural resources. These combined factors are significant forces contributing to vulnerability to natural disasters (Baumann et al. 2003). Changes in the precipitation patterns and any intensification of the monsoons will contribute to flood disasters and land degradation and will thus have far-reaching consequences for the entire economy (Stern 2006). In the last decade, India has been repeatedly battered by successive monsoons, flooding and droughts. For example, Odisha State has experienced floods in 49 of the last 100 years, droughts in 30, and cyclones in 11 years. The occurrence of droughts, floods and cyclones in a single year is not unusual. In addition, the number of villages in India experiencing drought is increasing (Tompkins 2002). India's water supply depends not only on monsoon rains but also on glacial melt water from the Hindu Kush and the Himalayas. Rising temperatures will cause snowlines to retreat further, increasing the risk of floods during the summer monsoon season (Greenpeace India 2010). Currently, as much as 68% of India is drought-prone and 12% (more than 40 million hectares) is flood-prone. India has a long coastline of about 7,516 kilometres of flat coastal terrain and shallow continental shelf with high population density, and it is extremely vulnerable to cyclones and its associated hazards like storm tide, high velocity wind, and heavy rains. Although the frequency of tropical cyclones in the North Indian Ocean, including the Bay of Bengal and the Arabian Sea, is the lowest in the world (7% of the global total), their impact on the east coast of India is more devastating in relative terms (Mittal 2010). About 8% of the area in the country is prone to cyclone-related disasters. The number of storms with more than 100 millimetres of rainfall in a day is reported to have increased by 10% per decade (UNEP 2009).

What is the contribution of EAS to Disaster Management?

EAS can join disaster management agencies to contribute towards (Chander 2019):

Box 5. Floods in 2017 and Droughts in 2018

In Bihar, flooding affected 21 districts with over 17 million residents. Araria, in the district of Jogbani, was the worst affected. At least 514 people died from the floods and landslides in the State in August. Although deaths due to flooding have been recorded in Bihar every year since the government started releasing data in 1979, this flooding has been described as the worst to affect the state since 2008. Seven thousand villages were affected, forcing 400,000 people to seek refuge across 1,358 relief camps. Bihar's State Government estimated crop damages to be INR 1,093 crore, and sought INR 10,000 crore from the Central Government to cover the damages in flood-hit areas.

In Uttar Pradesh, 2017, the flood caused the death of 104 people, with over 280,000 people affected in 24 districts. In West Bengal, 152 people died in the floods, and 400,000 people displaced and housed in 800 relief camps. Chief Minister Mamata Banerjee said that the State has incurred an estimated total loss of INR 14,000 crore because of the floods. Around 4.23 lakh hectares of agricultural land in southern districts and nearly three lakh hectares in northern ones were affected. The estimated loss to the agriculture sector was more than INR 6,500 crore.

In 2018, the Kerala flood submerged 45,000 hectares of farmland, including 20,000 hectares of rice paddy out of a total of 57,000 in the State. With just over half of the population (52.3%) in Kerala living in rural areas and dependent on rural livelihoods, the loss of the kharif crop impacted the livelihoods of millions. Dairy farmers were affected too, after the flood the daily milk procurement in the State decreased by 2-2.5 lakh litres a day, out of around 13 lakh litres per day, the Kerala Cooperative Milk Federation said at the end of August.

Tamil Nadu received 62% less rainfall and the drought was described as the worst in 110 years. The Tamil Nadu government declared a state-wide drought on 10 January, 2017. The drought affected 21 out of 32 districts in Tamil Nadu. Farmers ended their lives between October and December 2016.

In Gujarat State, major reservoirs began running dry in early 2018. The Narmada river, the main source of water in the State, was at its lowest level for 13 years, despite heavy rainfall last year. The government announced that water could not be used for irrigation. Across the state, reservoir water levels were 40% below normal in May 2018.

Bundelkhand, in Madhya Pradesh State, has suffered repeated droughts in recent years with thousands of water bodies drying up in the last decade. Many people from the region have migrated to escape the crisis - reportedly as many as 10,000 a day during the 2017 drought.

Parts of Maharashtra, such as Marathwada and Vidarbha have frequently been in drought in recent years. In the first four months of 2017, more than 850 farmers killed themselves in the State; some women have to spend most of their days collecting water. The Godavari river, which mostly gathers water from Maharashtra and Telangana, is also running dry.

Water shortages in Odisha are affecting people across the State, including in Rourkela and the Bonda tribal people, with some villages reportedly empty of farm workers, who have left to find work in cities.

In Punjab, major reservoirs are 39% below normal levels. Water shortages in the state are affecting agriculture, such as cotton planting, and could hit electricity production.

Source: *Indiaspend 2018*

- Understanding disaster risk, enhancing disaster preparedness for effective response and to 'Build Back Better' in recovery, rehabilitation and reconstruction, and strengthening disaster risk governance to manage disaster risk better;
- Training and education on disaster risk reduction, including the use of existing training and education mechanisms and peer learning;
- Promoting the incorporation of disaster risk knowledge, including disaster prevention, mitigation, preparedness, response, recovery and rehabilitation, into formal and non-formal education, as well as in professional education and training;
- Promoting national strategies to strengthen public education and awareness in disaster risk reduction, including disaster risk information and knowledge, through campaigns, social media and community mobilization, taking into account specific audiences and their needs;
- Enhancing collaboration among people at the local level to disseminate disaster risk information through the involvement of community-based organizations and non-governmental organizations.

Disaster risk reduction also involves building a wider understanding of risk and vulnerabilities through assessments, awareness raising campaigns, and information management. The systematic integration of disaster risk reduction into wider sustainable development efforts depends on having an effective enabling environment in place that is supported by sound legal and institutional frameworks. Translating concepts and plans into action requires technical expertise and technologies that have been proven effective at reducing hazards; early warning systems that reach vulnerable communities; and practices to enhance preparedness. It also requires that attention be paid to the lessons that have been learned from previous disasters so that affected communities can build back better after future emergencies (Figure 16).

EAS can disseminate tailored climate forecasts prepared by meteorological agencies to support farmers' seasonal needs through mobile phones, information centres, community radio, etc., and thus help farmers protect themselves from climate shocks and changes. These advisories, however, have to be context-specific and relevant to local situations since generalized messages often prove to be wrong, leading to lack of confidence in them by farmers. RAS can also motivate farmers by enabling them to buy index-based insurance giving them a measure of protection in the event of extreme weather. In this new paradigm, insurance pay-outs are pegged to easily-measured environmental conditions, or an 'index', that is closely related to agricultural production losses. Possible indices include rainfall, yields, or vegetation levels measured by satellites. When an index exceeds a certain threshold, farmers receive a fast, efficient pay-out, delivered via mobile phones in some cases.

What is disaster risk reduction in agriculture?

Disaster Risk Reduction (DRR) is aimed at preventing new, and reducing existing, disaster risks and managing residual risk, all of which contributes to strengthening resilience, and therefore to the achievement of sustainable development (UNISDR 2016).

It focuses on actions to reduce negative impacts on human safety and well-being resulting from hazardous events. In a DRR context, reducing the risk of disaster happening is done through three types of actions: 1) by taking preventative measures; 2) by

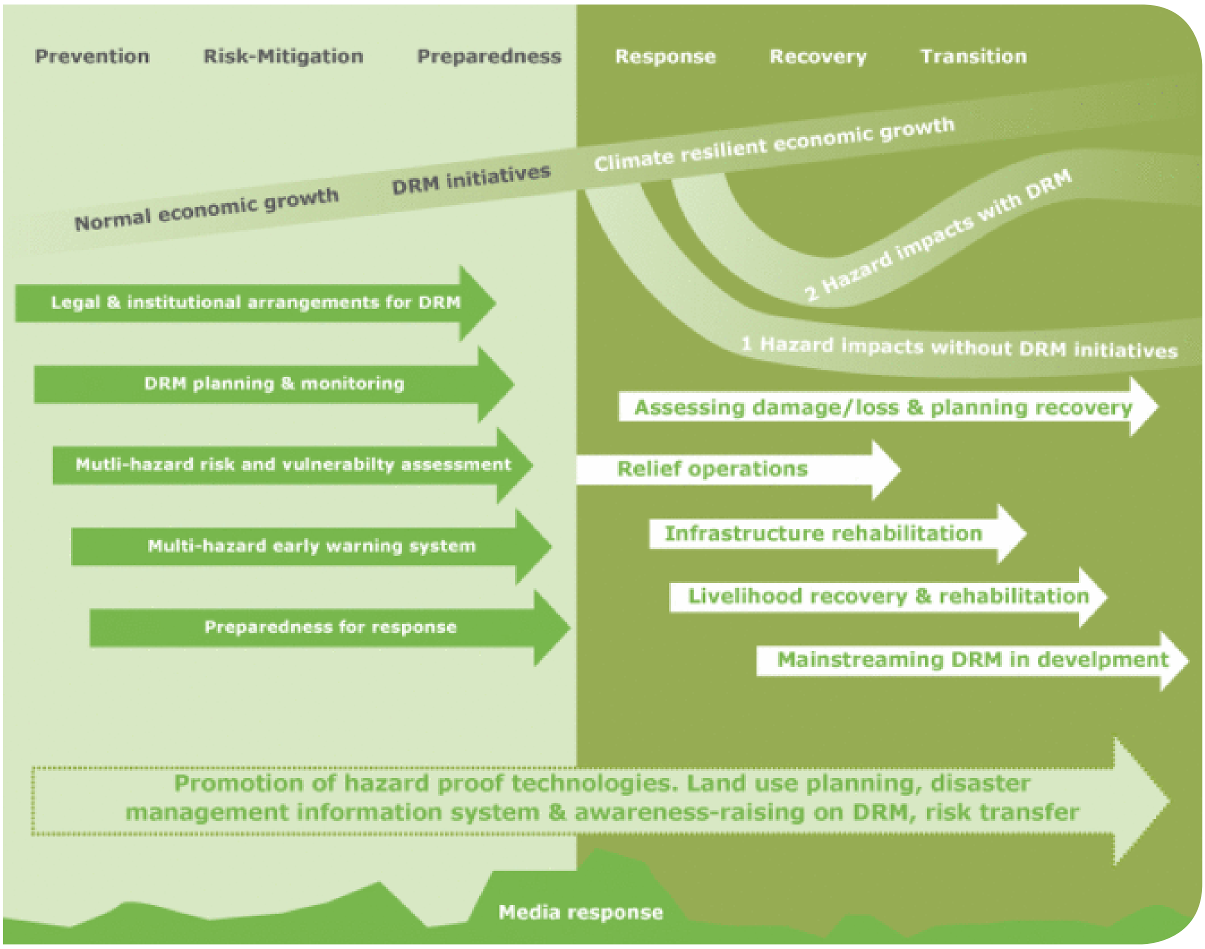

Figure 16: Disaster Management

Source: *FAO 2017*

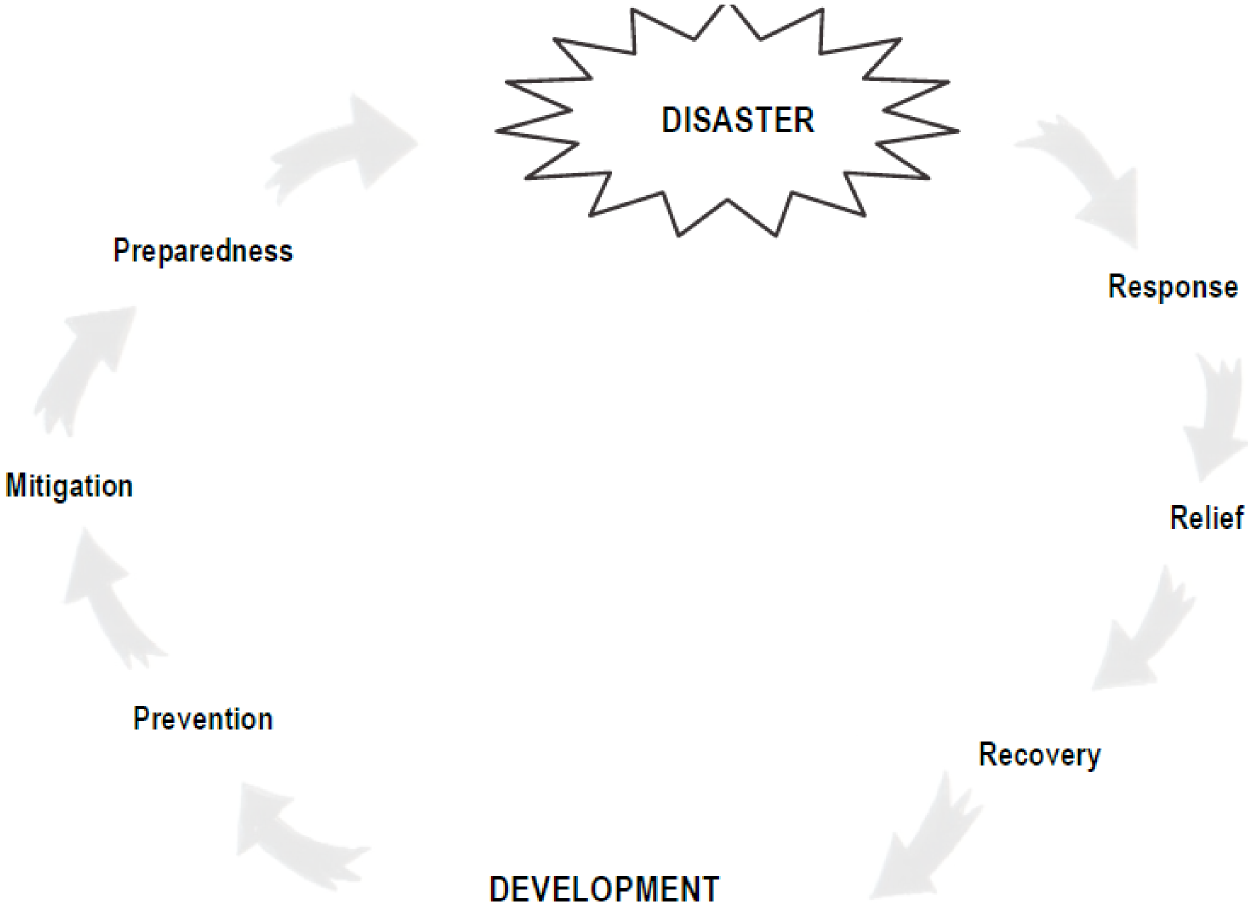

Figure 17: Disaster risk reduction components

taking actions that would mitigate the impact; and 3) by taking actions that prepare for the eventuality in case a hazardous event happens. Figure 17 illustrates the whole spectrum of risk reduction components – the disaster management continuum – including those noted as Disaster Management (DM) components, e.g., response, relief, and recovery measures taken after disaster has struck.

There are multiple pathways to reduce the impacts of natural hazard-induced disasters on the agriculture sector, at different levels – including farm level. The Sendai Framework for Disaster Risk Reduction 2015–2030, establishes four lines of priority action that, together, can effectively address the risk of natural hazards: 1) understanding disaster risks; 2) strengthening disaster risk governance to manage risk; 3) investing in disaster risk reduction for resilience; and 4) enhancing disaster preparedness to enable 'building back better' during recovery, rehabilitation and reconstruction.

There has to be closer integration between climate adaptation plans and management of disaster risks that engages local communities deeply. Converge the divergence of disaster risk reduction and climate change adaptation as both have the objective of reducing factors that contribute to specific risks while ensuring sustainability in socioeconomic development. Conventionally, CCA tackles various facets of the impact of environmental degradation in the domains of water, agriculture, health, and infrastructure with the development of new tools for early warning systems. These are the areas in which measures of integration must be considered (Figure 18). Within the purview of DRR, several mitigation and prevention measures can offset the potential of any hazard with approaches similarly taken under CCA. Such similarity may potentially be in terms of their nature, content, and approaches, which are employed to reduce adverse effects.

What are the good practices to follow in community based disaster risk management (CBDRM)?

The World Bank (n.d.) has identified a few good practices to be followed by EAS for effective CBDRM programmes:

- Recognize that local people and their organizations are the main actors in reducing risk and responding to disasters, and seek to involve them in defining problems, deciding solutions, implementing activities, and evaluating results;
- Build links between communities and the local and national authorities to promote greater complementarity between their respective roles in disaster risk management;
- Understand the important roles played by women in disaster management and fully include them in decision-making, implementation, and evaluation;
- Practices should be promoted based on a thorough analysis of the particular hazard and risk environment, including the vulnerabilities and capacities of the people affected;

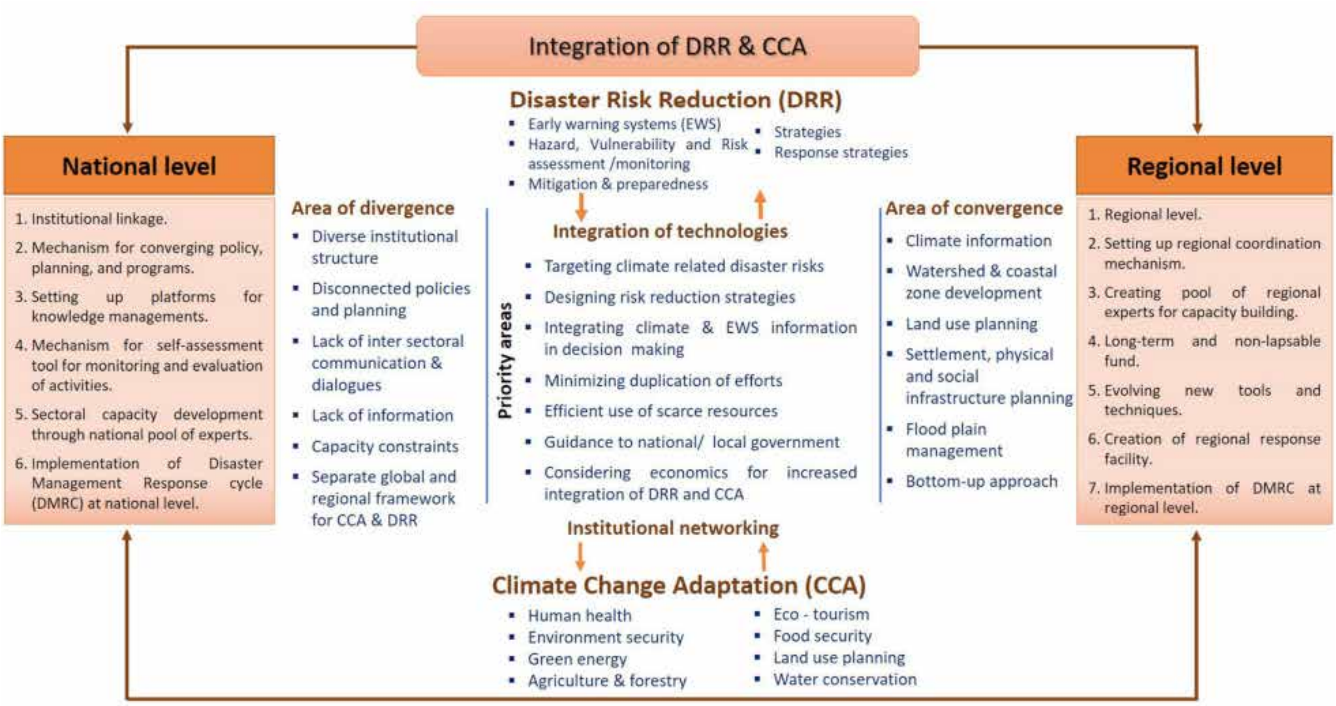

Figure 18: Schematic diagram showing a holistic approach for integrating disaster risk reduction (DRR) with climate change adaptation (CCA) over the South Asian region.

Source: *Dhar 2010*

The main tasks of risk communication

- *Identify aspects of risk.*
- *Present and explain risk information to relevant target groups.*
- *Modify the risk-related behavior of people exposed to risks.*
- *Warn individuals and communities.*
- *Develop disaster management strategies for the authorities.*
- *Stimulate community participation in disaster mitigation.*
- *Facilitate discussion and joint problem-solving between specialists and communities.*

Source: *Rohrmann 2004*

Box 6. Fields of action in the disaster risk reduction framework

Risk awareness and assessment, including hazard analysis and vulnerability/capacity analysis;

Knowledge development, including education, training, research and information;

Public commitment and institutional frameworks, including organisational, policy, legislation and community action;

Application of measures, including environmental management, land-use and urban planning, protection of critical facilities, application of science and technology, partnership and networking, and financial instruments;

Early warning systems, including forecasting, dissemination of warnings, preparedness measures and reaction capacities.

Source: *Vincent et al. 2008*

- Include attention to the needs and views of particularly vulnerable people who may be marginalized from participation on the basis of their gender, age, disability, ethnicity, socio-economic status, or other factors;
- Recognize that livelihoods are central to poor and vulnerable people's coping strategies and incorporate a specific focus on livelihood security whenever possible;
- Analyse the close link between environmental degradation and increased risk from natural hazards and incorporate appropriate environmental activities, to the extent possible;
- Treat information, education, and communication as a two-way process between communities and other disaster management stakeholders, combining local knowledge and practice with scientific and technological information to ensure that the disaster early warning, preparedness, and mitigation measures are appropriate to the local context;
- Design locally appropriate and sustainable technological interventions for risk reduction;
- Effectively design and resource baseline data collection and monitoring and evaluation systems;
- Maintain good community accountability systems and put them into practice;
- Promote knowledge-sharing, networking, and collaboration between different actors at local, national, and/or international levels to improve good practices.

Conclusion

The major challenge faced by the extension community is how to cope with unpredictable situations that will continue to emerge as a result of climate change. This unit tried to convey the good practices to be followed by EAS while contributing towards CSA and disaster management so as to minimize farmer suffering.

Cases

Case 5: Kerala floods 2018: How extension and advisory services supported farmers to deal with natural calamities

Kerala witnessed an unprecedented flood in August 2018, that critically affected the lives of people belonging to every walk of life. It is estimated that an area of around 57,000 ha with standing crops of various types were lost in the deluge. Apart from the loss of machinery, farming implements, harvested and stored produce, and damage to warehouses, irrigation channels, etc., the incalculable loss of top soil and soil nutrients, are almost always overlooked. Crops worth more than INR 5600 crore were lost, affecting around 400,000 farmers. Approximately 150,000 ha of cropped land was affected.

Extension's response to the floods

Dealing with the damage

The first concern was to protect the lives of farmers from a likely epidemic of leptospirosis, a distinct possibility due to a rise in the rodent population as a result of floods. The immediate response of the extension staff, especially of the State's Department of Agriculture, was to inform farmers on the need to take doxycycline as advised by the Health Department.

Flood debris were removed by the farmers themselves. In places where the quantity of debris was too much, farmers were given assistance to the tune of INR 12,500 per ha. In several places, government agencies like Kudumbashree (http://www.kudumbashree.org/) were engaged in de-silting activities. Support from schemes such as MGNREGS, were also used to implement these activities.

Extension functionaries visited each and every farmer to assess crop loss on a war footing. This helped the farmers to get government aid at the earliest. During the visits individual farmers were given instructions on how to save their remaining crops, and how to get income from their fields.

Farmers were advised to plough the topsoil so as to open up the soil's pores and allow the soil to breathe. This was essential to prevent the formation of hard impermeable aggregates that could affect soil aeration further. The silt and clay that was deposited above the topsoil was broken down by the farmers and mixed with the soil.

As regaining soil health was vital to re-start agriculture, soil test campaigns were conducted in almost all panchayats to assess the nutrient status of soil. In several places water-soluble nutrients, such as potash, calcium and magnesium, got dissolved and leached into the water. Soil acidity had increased considerably in most of the soils. Dolomite, gypsum, slaked lime and other soil ameliorants were supplied to farmers at a subsidised rate to regain soil health.

Beneficial microbes such as Trichoderma and VAM, were supplied to farmers to boost the population of helpful microbes in soils that can aid in root growth and nutrient uptake. On-farm multiplication of VAM and Trichoderma was taken up as a frontline demonstration in progressive farmers' fields. These microbes help in control of soil-borne pathogens as well.

Farmers were encouraged to enrich the microbial activity in soil by ploughing in lots of green matter, farmyard manure and compost. Adding paddy husk was also adopted by farmers as this too can help in improving soil aeration. Moreover it adds to the silica content of the soil. Cultivation of cover crops, especially leguminous crops, is promoted wherever possible as it will help in adding more organic matter into the soil and thus improving soil aeration and moisture retention as well as nitrogen fixation. Seeds of these crops were supplied to farmers. Farmers were advised to allow the growth of naturally occurring weeds as they have a deep root system that can improve soil porosity. They were also encouraged to adopt mulching of soil with organic matter, such as dried leaf and crop residues as this helps in moisture retention, ensures soil porosity, and improves microbial activity. Short duration vegetable crops – particularly amaranthus and cucurbits – can help the farmer to get some income immediately after the flood. So seeds and seedlings of these crops were supplied to farmers free of cost. Extension staff convened campaigns under the title 'Punarjani' (meaning 'rebirth') on the worst affected farmer fields to clear the debris, and add soil ameliorants. Seeds and seedlings were planted in these fields by extension staff.

Building resilience

Earlier, farmers were reluctant to purchase crop insurance launched by the Department of Agriculture Development & Farmers' Welfare (Kerala). But the floods have changed their attitude. Farmers currently recognize the importance of insurance as these types of unpredictable calamities and crop damage are likely to increase due to the changing climate. Wide publicity is currently being given to the crop insurance scheme so that farmers can take up agriculture confidently. Under the leadership of the Agricultural Technology Management Agency (ATMA), farm schools, farm field schools, capacity-building meetings, kisan gosthis were conducted in all panchayats to popularize scientific intervention in agriculture and allied fields. Under the crop health programme, extension staff are deployed to keep a vigil on the occurrence of pests and diseases. Farmers are also being encouraged to take up additional activities, such as fisheries, animal husbandry, and value addition so as to have a steady income.

Source: *Nair, 2019*

Tools

Tool 1

Checklist for Agriculture, Food Security and Livelihood

A set of checklists are given in the following sub-sections for vetting different projects/ developments through the lens of DRR and CCA, as well as to check that they protect the communities from future disaster risks and do not increase their vulnerability to disasters. Each question is to be answered with a 'Yes' or 'No' with specific remarks for the answer, if required.

Table 4: Checklist for Agriculture, Food Security and Livelihood.

No.	Description/Checklist	Yes	No	Remarks
1	Is the mapping of land use pattern conducted at the district level?			
2	Are the different land use zones identified in the district?			
3	Are the types, frequency, and severity of potential disasters identified in the area?			
4	Are bunds constructed along arable lands of villages to prevent river ingression and soil erosion?			
5	Are locally appropriate solutions, such as the construction of check dams/minor irrigation tanks, etc., undertaken to regulate flow of rain water?			
6	Are there safe and appropriate storage facilities available for quality/hazard-resistant seeds?			
7	Can the farmers easily access quality/hazard-resistant seeds?			
8	Are there extension activities undertaken for training farmers?			
9	Are there mechanisms set up for integrated pest management?			
10	Is there a regular and functioning system existing to advise farmers on various agricultural issues free of cost in the local language?			
11	Is there a regular and functioning system for training of farmers on creation and maintenance of grain and seed banks?			
12	Is there a supportive, accessible, and functional system present to ensure remunerative prices to farmers?			
13	Is there an accurate, reliable and functional system present to track changes in weather patterns and their impact on agriculture, and further document it and disseminate among farmers?			
14	Are farmers linked with risk sharing and transfer instruments such as crop/ livestock/fishery insurance, compensation and calamity funds, micro/credit and cash transfers, etc.?			
15	Are there enough seeds, fertilisers and pesticides available in the market? (This may be done by establishing agriculture input hubs.)			
16	Is there a system for quick de-watering and clearing of cultivable lands on a priority basis?			
17	Is there provision for cash support/interest-free loans for farmers for sowing of crops in a post-emergency situation?			
18	Is there a functional mechanism (such as Flood Forecasting System) to advise farmers on appropriate crop selection (testing and introducing new varieties, drought/saline/flood resistant crops, quick growing crops) and animal breeding; improved cropping systems and cultivation methods (crop diversification, intercropping, adjustment of cropping calendars, soil conservation); and post-harvest management (storage, food drying, food processing) etc.?			

19	Is there a functional system present to preserve animal stock by supplying supplementary feed, vaccination and standard medication, such as deworming for cattle, sheep, goats and other such livestock?			
20	Is there a well-defined and efficient coordination mechanism established at village level, block level, district level, state level and national level?			
21	Is there a functional mechanism available to improve communication and coordination between the various stakeholders within the agriculture sector, as well as outside this sector?			
22	Are workshops/seminars/sharing forums organised for demonstration and sharing of good practices for DRR from sectoral/cross-sectoral perspective to increase the resilience of existing farming systems?			
23	Do functional systems and mechanisms exist to promote livelihood diversification, which may include small-scale enterprise development, and introduce new farming activities (small-scale livestock, fish ponds, new crops of higher market value etc.)?			

Table 5: Checklist for Animals and Fisheries

No.	Description/Checklist	Yes	No	Remarks
1	Are the animal treatment centres and medicine storage etc., multi-hazard resistant (for flood, earthquake, fire, cyclone etc.)?			
2	Are the veterinary hospitals constructed at strategic locations, and away from flood-prone areas?			
3	Are the artificial insemination centres constructed at strategic locations, and away from flood-prone areas?			
4	Are the fodder banks established at safe places with multi-hazard resistant features (for safety against flood, water logging, earthquake, cyclone, fire, etc.)?			
5	Is earthquake and flood resistant renovation done for the fishponds and ox-bow lakes?			
6	Are trainings and awareness programmes conducted for fish farmers in scientific aquaculture?			
7	Is renovation of water bodies done through village level committees comprising of PRIs, fish farmers, etc.?			
8	Is there a mechanism for cross-learning, sharing and exposure visits, etc., for farmers (cattle, fish, goat, poultry farmer, etc.)?			
9	Are regular awareness-building processes conducted among the departmental staff, communities and the key stakeholders engaged with the department on potential disaster risks and measures to reduce the risk?			
10	Are funds earmarked for mitigation measures (such as reconstruction work) in the sector?			

Source: *DMD&UNDP 2017*

Tool 2

Assessing risks and defining a disaster risk reduction plan

a. Identifying hazards and vulnerabilities

A common matrix forum is used to identify elements, the first being the hazard, e.g., what it is, and how often and/or frequent the hazardous condition occurs. The next step is to define people's vulnerability to the hazard, and this is often taken in the context of impact and/or losses occurring as a result of the hazard.

Table 6: Community managed disaster risk reduction hazard and vulnerability matrix

Risk	Hazard		Vulnerability	
	What	Frequency/Strength	Impact-1	Impact-2
	Drought	Once every five years on average	Loss of agricultural crops	Financial debt build up
	Flood			
	..			
	..			
	..			

b. Identifying capacities and actions to reduce vulnerability

Fill in Table 7 by thinking about what capacities are needed to prevent, mitigate, and prepare for hazard impacts (as listed in Table 6 under vulnerability). This may be a combination of structural needs, knowledge, skills, to policies, etc. Identify the current level of capacity among stakeholders to address impacts (listed in Table 6). Consider only current capacities in use at the field level, not potential capacities or 'if' situations. Identify capacity building actions under each context, e.g., prevention, mitigation, and preparedness. Areas of low capacity should be prioritized for action.

Table 7: Sample matrix as the second part to Table 6

Capacities Needed to Address the Impacts			**Current Capacities**			**Needed Capacity Building Actions**		
Prevention	Mitigation	Preparedness	L	M	H	Prevention	Mitigation	Preparedness

L = low, M = medium, and H = high

c. Building a localized disaster risk reduction action plan

Use Table 7 as a guide to develop a localized disaster risk reduction action plan. As noted earlier, focus should be on building capacities in areas where currently capacities to reduce vulnerability are low, but should also be focused on do-able actions within the short and medium term.

Table 8: Sample disaster risk reduction action plan matrix

Capacity Building Needs	Method/ Procedure for Capacity Building	Partners/ Stakeholders Involved	Partner/ Stakeholder Responsibilities	Needed Resources/ Budget	Planned Outputs and Outcome	Time Frame	Potential Obstacles and Way to Address These
Prevention							
Mitigation							
Preparedness							

Source: *Solar 2014*

Tool 3

Gender-sensitive M&E indicators for disaster management

Indicator	Means of Verification
Number of deaths disaggregated by gender, age, location; Percent of women and men receiving extreme weather information and bulletins through targeted dissemination methods; Percent of women on disaster preparedness committees; Number and percent of women and men receiving gender-specific disaster training; Gender-disaggregated statistics on male and female beneficiaries receiving land allocations, emergency rations, replacement livestock, seeds, loans; Satisfaction levels of women and men with post-disaster management and reconstruction; Number and percent of women reporting violence per month (threats, beating, rapes); Percent of women and men with access to insurance packages; Changes at start and end of emergency support in women and men's levels of nutrition, health, education, vulnerability.	Government records; Focus groups/household surveys/media/non-governmental organizations (NGOs), especially women's groups; Networks of health organizers, community organizers and human rights defenders; Community meeting minutes; Women's community-based groups and NGOs; Training records Agricultural extension records; Camp management records; Regional land department records; Focus groups/interviews with stakeholders; Interviews with community leadership, police records; Refugee camp management records; Household surveys; Project Management Information Systems; School records.

Source: *World Bank 2008*

Exercises

Exercise 1

Group Exercise (Divide the participants into four groups)

Which are the groups vulnerable to climate change and why are they vulnerable? How do extreme events/ climate change affect them? What can be done to make them less vulnerable? What systems (institutions) are in place to support them and how? What are the policy options to address extreme events/climate change?

No.	Who are the people most affected by climate change?	Why?
	Small farmers living in drought prone semi-arid areas	
	Population living in coastal areas and low-lying flood plains	
	Small scale fishermen and coastal communities	
	Indigenous people living in mountains, including forest dwellers	

Source: *FAO 2009*

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Unit V:
Gender and Climate Smart Agriculture

Objectives

- Discuss how gender gap affects adaptation to climate change in agriculture;
- Understand the gender responsive interventions in CSA.

Introduction

Does gender matter in climate change adaptation? Yes, gender matters, because women in poor rural households commonly face higher risks and greater burdens from the impacts of climate change. Women play a critical role in natural resources management within their households. Women are responsible for over 70% of water-related chores and management globally. In India alone, women make up over 65% of the agricultural workforce. So understanding gender issues is essential to efficiently deal with climate change and achieve climate smart agriculture.

This unit tries to examine the different roles of men and women in agriculture and how climate change affects those roles. Also it looks at gender specific vulnerabilities and how to manage them through a gender-responsive approach in climate smart agriculture.

In India, the situation is worse. Men migrate to urban areas to find work in factories/ construction sites as they expect lower yield and income from their farm fields. Women in the family are left to take care of all the household chores and the farming duties. To deal with the new challenges women should be granted ownership of, and access to, resources.

Discussion

Everyone matters when it comes to adapting to climate change. It cannot be for a particular class of people or just for men, instead everyone should have a say in how climate change occurs and how to adapt to adverse impacts of climate change in an equitable manner. The impacts of climate change are experienced by men and women in different ways. The difference in gender roles and responsibilities may lead to different perceptions and knowledge about climate risks, and how it may affect their livelihoods and how to respond to this challenge. They also have differential access to the resources and services needed to adopt climate smart practices.

VIDEO

Let us start the session with a video

Closing the gap between men and women in agriculture *(2:15 minutes).*

The film explains that the world cannot eliminate hunger without closing the gap between men and women in agriculture. With equal access to productive resources and services, such as land, water and credit, women farmers can produce 20 to 30% more food, enough to lift 150 million people out of hunger. The film can be presented to introduce the gender gap in agriculture.

The link to the video: https://www.youtube.com/watch?v=uDM828TpVpY

Gender Gaps in Agriculture

The gender gap in agriculture is a pattern, documented worldwide, in which women in agriculture have less access to productive resources, financial capital and to advisory services compared to men (FAO 2011). Due to traditional gender-based discrimination, women have fewer privileges, entitlements and endowments. This affects their vulnerability and adaptive capacity to climate threats.

Gender roles in agriculture can change depending on circumstances (e.g., the men migrating to cities for seasonal work) or the introduction of technology (so that the other gender can take over), typically these agricultural roles are more or less defined. Table 9 below shows some of the typical ways in which farm tasks are divided.

Gender-specific consequences in the context of climate smart agriculture vary by the degree to which women can equally access resources such as land or livestock, services, employment and business opportunities (World Bank, FAO and IFAD 2015). It has been estimated that closing the gender gap in agriculture would reduce the number of hungry people by 100-150 million (FAO 2011). It is not only the access that is important though, control over resources, such as land titling and tenure rights are equally important issues. Women who have access to higher quality (and not marginal) resources are less burdened and are able to produce more. The gender gap in agriculture and ways for reducing the gaps has been documented in Table 10. Climate change exacerbates the existing barriers that women face. Gender inequality and climate change consequences intersect in multiple dimensions (Figure 19).

Table 9: Popular separation of gender roles in agriculture

Women's Sphere	Men's Sphere
Producing staple crops (wheat, rice); Sowing/planting	Handling cash crops and commercial agriculture; Preparing lands for sowing;
Weeding; applying fertilizers and pesticides; Harvesting, threshing	Irrigating crops;
Milking livestock (cows, goats);	Transporting produce to market;
Managing small livestock (e.g., family poultry); Maintaining the household: raising children; growing and preparing the family's food; collecting fuel wood and drinking water;	Owning, managing, and trading large livestock such as cattle;
	Cutting, hauling, and selling timber from forests;
Generating income via processing produce for sale; selling vegetables from home gardens or forest products	Fishing in coastal and deep seawaters.
This income generally goes toward meeting the family's food needs and child education.	

Source: *Vincent 2011*

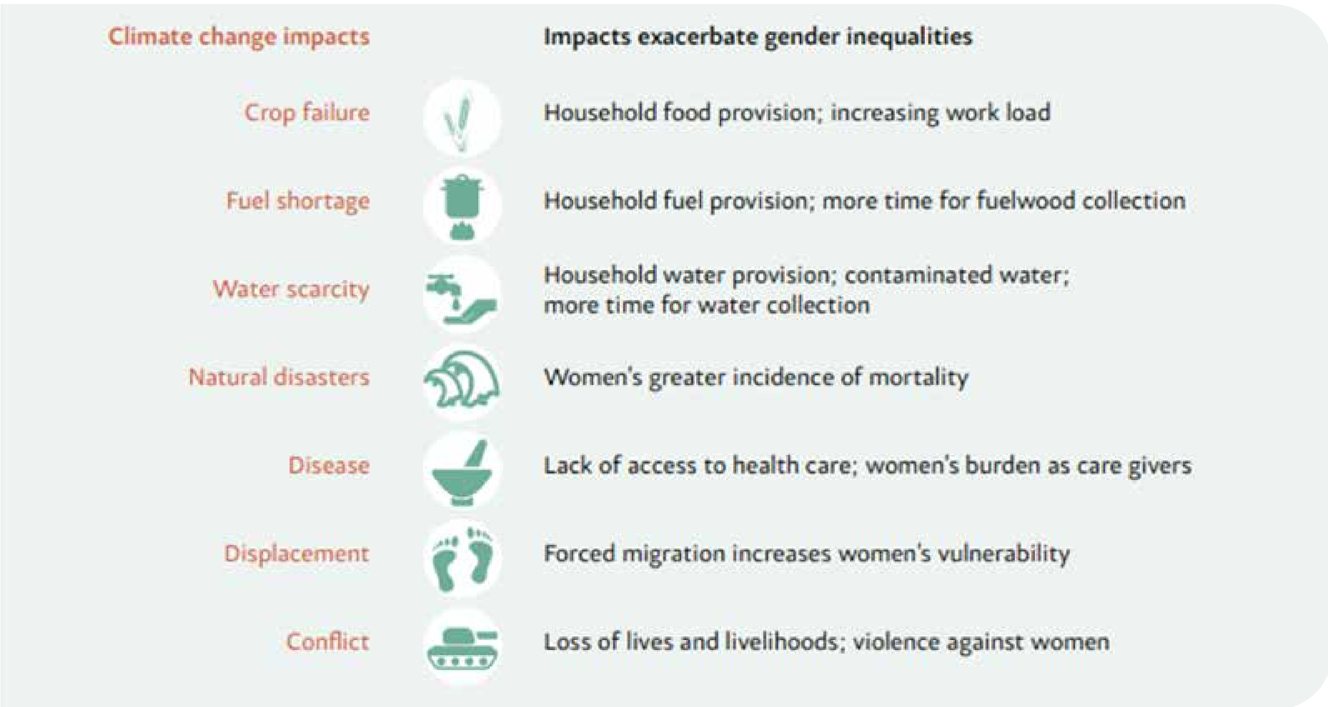

Figure 19: Climate change exacerbates gender inequalities

Source: *WEDO 2012*

Table 10: Gender gap in agriculture

Assets or resources	The gender gap	How to close the gap
Land	Men hold title to a disproportionate amount of land. *In South Asia, women constitute two-thirds of the agricultural work force but own less than 10% of agricultural lands.*	Closing the gap in access to land and other agricultural assets requires, among other things, reforming laws to guarantee equal rights, educating government officials and community leaders and holding them accountable for upholding the law. It also involves empowering women to ensure that they are aware of their rights and able to claim them.
Labour Markets	Farms run by female-headed households tend to have less labour available for farm work because these households are typically smaller and have fewer working-age adult members. Furthermore, women have heavy and unpaid household duties that take them away from more productive activities. *In India, women agricultural workers get 50% lower average wage for casual work, and 20% lower wage for the same task, as compared to men.*	Women's participation in and access to rural labour markets requires freeing women's time through labour-saving technologies, and the provision of public services. It also entails raising women's human capital through education, eliminating discriminatory employment practices, and capitalizing on public work programmes.
Financial Services	Access to credit and insurance are important for accumulating and retaining other assets. Smallholders everywhere face constraints in accessing credit and other financial services, but in general, female smallholders have less access to loans, for example, as they generally have less control over the types of fixed assets necessary as collateral for loans. Female smallholders may also face institutional discrimination where they are offered smaller loans compared to male smallholders.	Closing the gap in financial services requires legal and institutional reforms to meet the needs and constraints of women, along with efforts to enhance their financial capacity. Innovative delivery channels and social networks can reduce costs and make financial services more readily available to rural women.
Education	Education has seen improvements in gender parity at the national level, with females even exceeding male attainment levels in some countries, but in most regions women and girls still lag behind. The gender gap in education is particularly acute in rural areas, where female household heads sometimes have less than half the years of education of their male counterparts. Nevertheless, recent years have shown significant gains, especially in primary school enrolment rates for girls.	Women's groups and other forms of collective action can be an effective means of building relations and networks and addressing gender gaps in other areas as well, through reducing transactions costs, pooling risks, developing skills and building confidence. Women's groups can be a stepping stone to closing the gender gap in participation with other civil society organizations and government bodies, and in improving access to education.
Technology	Women are much less likely to use purchased inputs and improved seeds or to make use of mechanical tools and equipment. In many countries women are only half as likely as men to use chemical fertilizers. Within the agricultural realm, women also have much less access to agricultural extension workers.	Improving women's access to agricultural technologies can be facilitated through participatory gender-inclusive research (e.g., field trials with women), and technology development programmes, the provision of gender-sensitive extension services and the scaling up of Farmer Field Schools, Self Help Groups, and Producer Organisations.

Source: *Vincent 2011; FAO 2011*

Gender Responsive Approach to Climate Smart Agriculture

To address the gender gap in agriculture we need to adopt a gender-responsive approach. In practice, this means that the differentiated needs, priorities, and realities of men and women are recognized and adequately addressed in the design and application of climate smart agriculture so that both men and women can equally benefit (World Bank, FAO and IFAD 2015). The ultimate goal of a gender-responsive approach to climate smart agriculture is to give women and men the same incentives and opportunities to invest in or adopt climate smart practices.

In designing capacity development interventions for climate smart agriculture, it is important to identify which approaches will address immediate needs of men and women, and which approaches can promote a shift toward lasting equality between women and men. The more immediate needs are referred to as men and women's ***practical gender needs***, such as employment and food for the family, and these can generally be addressed through extension services. On the other hand, ***strategic gender needs*** – equal

Actions to address practical needs

- *Provide training on ecosystem service opportunities of agroforestry for women and men;*
- *Organize training on fishing gear maintenance skills for men and women;*
- *Introduce improved stoves and other household labour-saving practices;*
- *Provide vaccines for small livestock handled by women, as well as for larger animals.*

Actions to address strategic needs

- *Introduce incentives and land renting agreements for landless women;*
- *Organize informal education activities for illiterate women, including both technical and soft skills development;*
- *Involve women and men in decision-making roles on farming committees;*
- *Encourage cooperation with neighbouring communities for larger ecosystem service projects that involve support from both women and men.*

Source: *FAO 2018*

VIDEO

Let us see one short video

***Missing: The forgotten women in India's climate plans** (13.59 minutes).*

This film follows the Nahi women in their daily fight against climate change impacts. It shows how resourceful these women are in a context of severe constraints and poverty. Supporting their local initiatives with adequate policies and laws could be a significant game changer in the way India manages to tackle climate change. 'Missing' intends to convince policymakers of what can be achieved, were women to become integrated in climate change planning. The film depicts Rita Kamila and her success at integrating farming practices with climate resilience. As a result of the changing climate, Rita has fish in her fields; she puts her chicken coop over the water so that when she feeds her chickens, some of it falls through into the water, and the chicken droppings also become fish food. Her practices have led to great economic benefit, and she shares her knowledge with her fellow villagers. However, Rita's success is an isolated story, as the video shows, and it is critical to scale up access to government schemes. Many government schemes are only for land owning farmers and less than 10% of female farmers own land.

The link to the video: https://www.youtube.com/watch?time_continue=454&v=CgnW_Km7YQA&feature=emb_logo

***Source:** CDKN 2014*

access to resources, elimination of discrimination and adequate participation in decision-making mechanisms – require long term commitment and changes at different levels in society. Meeting these strategic needs is fundamental to advancing toward gender equality. Possible actions to address practical and strategic gender needs can blend into each other as they determine the path for developing adaptive capacities (FAO 2018).

How to conduct gender analysis for CSA?

Gender analysis is the study of the different roles of women and men in order to understand what they do, what resources they have, and what their needs and priorities are. As of now no blueprint exists to conduct a gender analysis. Therefore different approaches can be adopted but it should cover major questions aimed at understanding gender relations in the context of climate change (Figure 20).

What is the role of EAS in Gender responsive CSA?

To ensure that both women and men benefit equally from climate smart interventions, special attention must be paid by extension staff so that women can equally participate in the design, testing and implementation stages of the intervention. Demonstrations and study tours are usually an effective way to expose men and women agricultural

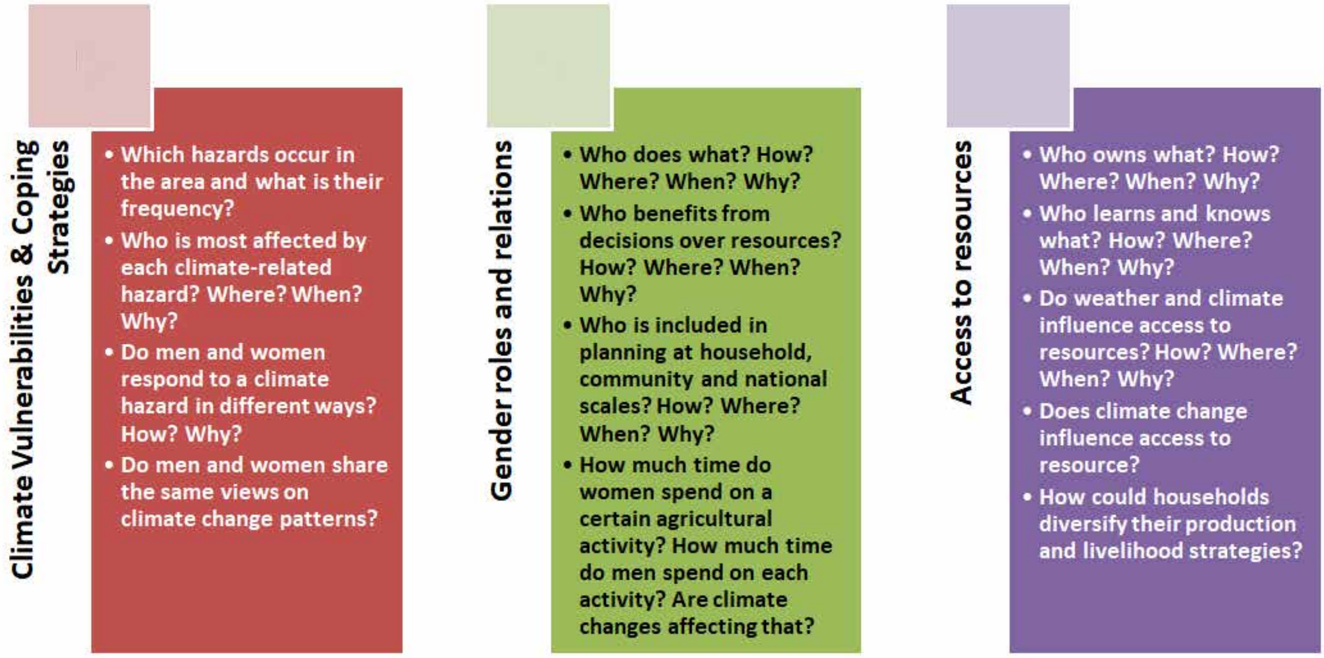

Figure 20: Gender analysis for CSA

producers to new climate smart practices; but enabling women's participation may require special arrangements according to the specific social and cultural context. This includes ensuring that both male and female extension agents are present to interact with male and female producers, and that they organize separate groups if women are not allowed in mixed groups, or if they are reluctant to contribute in mixed groups. In addition, practical choices such as the timing and location for organizing extension events and the availability of childcare should be considered to maximize attendance by all

Gender responsive CSA

- *Substitute conventional technologies with more efficient ones for men and women, in terms of reducing time and energy requirements.*
- *Create new incentives for adoption and financing mechanisms, making them accessible to both men and women.*
- *Introduce gender-sensitive technologies and methodologies (such as machinery and tools that can be easily handled by women and children).*
- *Build on men's and women's indigenous knowledge of local resources and climate change.*
- *Increase women's access to advisory services, education, information, and decision making.*
- *Organize tailor-made training on leadership and negotiation skills for men and women.*
- *Raise the gender awareness of policy makers.*
- *Support the design of gender-responsive policies, strategies, and action plans.*
- *Organize gender-responsive capacity development and communication.*
- *Support men's and women's organizations and networks.*

Source: *FAO and World Bank 2017*

actors in the community. During the implementation of a climate smart intervention, additional practical gender considerations must be taken into account, beyond those that can be arranged during direct contact with communities considering climate smart practices. If the adoption of a practice requires access to credit based on land ownership, women's lower levels of land ownership and consequent inability to access credit must be addressed from the outset. In addition, differences in literacy levels and in access to and use of various information sources - newspapers, internet, radio, informal groups, organized events or shows - should be considered when planning for dissemination of information relating to climate smart agriculture (FAO 2018).

Conclusion

This unit provided guidance to EAS on the importance of integrating gender in CSA practices, which is to reduce gender inequalities and ensure that men and women can equally benefit from any intervention in the agricultural sector to reduce risks linked to climate change. It also tried to examine the different roles of men and women in agriculture and how climate change affects those roles. This unit aimed to inspire EAS to explore the possibilities of gender-responsive CSA.

Cases

Case 6: Integrating Gender into the Climate Smart Village (CSV), Betul, Madhya Pradesh (MP)

Betul district in Madhya Pradesh is dominated by the Scheduled Tribes whose primary occupation is farming, although, in a conventional form with minimal use of technology and information. Agriculture is primarily rainfed and is characterized by low productivity. As a secondary income source households are dependent on casual wage labour to meet their basic household expenditure and dietary requirements. Most of the villages are located on a hilly terrain and do not adopt water recharge measures. Additionally, a gender and climate risk-related assessment identified the district as a hotspot having a larger proportion of women labourers and cultivators in agriculture, while facing higher climate risk of drought, as compared to other districts in the State. Twenty-five villages were selected based on consultation with local stakeholders (Non-Governmental Organization and government Agriculture Department officials) and discussions with the farmer groups.

Baseline assessment

Four major crops define the agricultural activities in the district – rice and maize in Kharif (monsoon) season, and chickpea and wheat in Rabi (winter) season. Maize and wheat form an important part of the region's staple diet and are grown by most of the households. In case of lower rainfall, the cropping pattern shifts towards maize and chickpea. The yields of crops, such as wheat, are lower than the State's average, highlighting the scope for improvement through efficient use of resources. On average, a household owns four cattle, one buffalo and one sheep or goat in Betul. Fodder and feed management are the key activities in animal husbandry. Majority of the farmers (66%) use fodder from their own land while 60% of them practice free grazing in private or communal lands. Use of crop residues for livestock feed is practiced by 55% of the households. Milk yields are very low and only used for the family's consumption.

Climate risk impact

Farmers identified multiple climate-related changes faced by them in the last few years. According to both women and men farmers, delayed monsoon and decrease in rainfall are the most significant risks in Kharif season that often lead to water scarcity for irrigation, resulting in delayed or no crop sowing in some cases. Also, excess rainfall after a period of low/no rainfall adversely affects the sown crops. Increased pest incidence due to high temperature and humidity is a common phenomenon in Rabi crops leading to increased use of pesticides and insecticides. Maize and rice crops are most affected by these changes. Less rainfall in the Rabi season also affects the overall water availability in the village impacting the production of wheat and vegetables. Heat waves during summers impact the health of livestock, further reducing their milk yields. Given the subsistence nature of farming in the villages, crop loss or lower yield directly affects food consumption making them dependent on markets to realize part of their food intake. Additionally, a lower income coupled with increased input cost also increases dependency on credit from the local trader to meet household requirements.

Coping mechanisms

Women and men farmers had similar responses to managing climate risks – highlighting the involvement or awareness at the household level. They said that the most common strategy for maize and rice crops (monsoon season) is to change sowing dates, change crop type and reduce the areas cultivated. Some farmers also buy water from those having irrigation facilities at a rate ranging from INR 500-1000 per acre. In the case of vegetables and wheat (winter season), however, the most common coping mechanism to prevent crop loss is to 'do nothing'. In case of pests, the farmers noted that despite increasing pesticide application, they are unable to minimize losses. To compensate for the loss in crop and as a result in incomes, due to weather risks, they work as wage labourers in other farmers' fields (mostly by women) or undertake off-farm employment in nearby towns (mostly by men). This is a common strategy adopted across households. In addition, women farmers also noted that in cases of major income loss, they sell their jewelry to sustain the family. In extreme cases, all the family members reduce their food intake so as to curtail food-related expenses.

Gender roles and decision making

The role of women and men in agriculture as well as in decision making was discussed with women and men farmer groups separately. These discussions revealed slightly different roles. As per all women and men groups, tasks involving technology selection and use are mostly done by men whereas women's contribution is mostly labour intensive. Similarly, activities involving market access are men's responsibility while women's work is limited to the farm and household. Irrigation is considered a man's activity and in the absence of a male household member, a male labourer is hired for the task. In terms of decision making, it was highlighted that in most cases, the doer is often perceived as the decision maker. Women and men take decisions together during pre- and post-crop season, while in-season farming decisions are primarily men driven. Women have an equal say in important decisions of selling produce as well as livestock. They are also responsible for managing household expenditure. Both women and men are actively involved in livestock-related activities as well, but taking care of the animals is primarily women's responsibility while the men are more involved in milking, grazing and selling.

CSV design

Prioritization of potential interventions

Based on the production system, agro-ecological conditions, nature of climatic risks, type of farmers, gender assessment and other baseline information, a list of 55 relevant CSA technologies, practices and services was prepared. The list of the CSA options included: weather, water, seed/breed, nutrient, energy and knowledge-smart agriculture technologies, practices and services (CCAFS 2016). An initial participatory prioritization exercise was conducted with three women and three men farmer groups to understand their preferences of technologies, practices and services as per their priorities. All 55 interventions were explained in detail to the group members. The costs and benefits of each technology/practice were also highlighted. Each group shortlisted 20 options and ranked them in keeping with their preferences. During the ranking exercise, technologies and practices related to water management and conservation were given higher priority by both women and men, given the climatic conditions and water scarcity. Apart from that, improved seeds, weeding machine and zero-tillage were prioritized by women farmers while men prioritized livestock insurance, use of farmyard manure and weeding. The weeding machine was prioritized for its labour-saving feature and ease of use by the farmers.

Super Champion	Champion farmers	CSA farmers	Other farmers
➢ Improved seed	➢ Improved seeds	➢ Improved seeds	➢ ICT based weather and agro-advisory services including market information
➢ ICT based weather and agro-advisory services	➢ ICT based weather and agro-advisory services	➢ ICT based weather and agro-advisory services	➢ Information about weather resilient technologies
➢ Crop insurance	➢ Crop insurance	➢ Crop insurance	
➢ Water management	➢ Water management	➢ Area specific mineral mixture for livestock	
➢ Integrated nutrient management (based on LCC, Green Seeker)	➢ Integrated nutrient management (based on LCC, Green Seeker)	➢ Fodder management	
➢ Alternative wetting and Drying	➢ Fodder management	➢ Concentrate feeding for livestock	
➢ Direct seeded rice	➢ Concentrate feeding for livestock		
➢ Minimum tillage	➢ Stress tolerant high yielding breeds of livestock		
➢ Fodder management	➢ Area specific mineral mixture for livestock		
➢ Concentrate feeding for livestock			
➢ Stress tolerant high yielding breeds of livestock			
➢ Area specific mineral mixture for livestock			
➢ Weather smart housing for livestock			
➢ Bio-gas			
➢ Solar pump (in group)			

Figure 21: Portfolio of technologies for different categories of farmers

Selection of farmers

Three categories of farmers were selected for the implementation of all CSV activities namely, Super Champion[2] , Champion[3] and CSA[4]. One woman SuperChampion, 14 women Champion farmers, and 134 CSA women and men farmers were selected from each of the 25 villages to lead the technology implementation for creating evidence. These farmers were provided training and capacity building exercises for implementing the portfolio of technologies and practices in their farms.

Institution building

Group formation: A committee by the vernacular name of 'Gram Jalvayu Samiti' (Village Climate Management Committee: VCMC) has been formed in each village to work as an informal body headed by a Chairman (the Super Champion farmer). About 80 women SHGs, involving a total of 900 women farmers across 25 villages are represented through the VCMCs. This committee is responsible for the management of CSV project activities. The committee members are actively involved in the design, selection, monitoring, and dissemination of CSA interventions in their villages.

Custom hiring center: Farmers in the district are small landholders and have low investment capacity for technologies. With the objective of creating a sustainable farm model, five custom hiring centres have been established to provide access to affordable and relevant climate smart technologies and practices to the centres members as well as to other farmers. These centres are run by women farmers who manage as well as use the technologies for agricultural operations. Equipment available in these centres include sprinkler set, spray pumps, manual crop harvester, weeding machine, zero-tillage machine, seed driller, paddy transplanter, and portable solar irrigation pump system.

Key activities for CSV formation

Improving farmers' access to better seeds: Seed of major crops in the CSVs – wheat, grams and mustard – were replaced with drought/insect/pest tolerant high yielding varieties in all Super-Champion and

Champion farmers. These seeds were also distributed to CSA and other farmers in the CSVs. Vegetable cultivation was also promoted among some Super-Champion and Champion farmers for cropping system intensification and income generation. All Super Champion and Champion farmers were trained on seed treatment, nutrient application and intercropping of wheat with legumes and mustard crops.

Capacity building and trainings: Training and capacity building of farmers on usage and relevance of various CSA technologies and practices were given for a total of 835 women and 61 men.

Establishment of cattle development centers (CDC): To promote improved cow breeds (Holstein, Friesian, Jersey, and Sahiwal) and buffalo breeds (Murrah), preventive animal health care, and capacity building training for health and feed management. A total of 114 households benefitted from this intervention and are now seeing significant improvement in milk production.

Promotion of clean energy development: To increase farmer's access to clean and renewable energy for use in their farms and households, five biogas models and five portable solar irrigation systems were provided to Super-Champion farmers for demonstration in the CSVs. The objective was twofold: to reduce carbon emissions, and to reduce women's drudgery through reduced labour in firewood collection and preparation of cattle dung cakes. The biogas slurry is also being used to produce vermicompost which is being applied directly in the fields for vegetable and fruit cultivation. Solar irrigation system facilitates access to water at affordable rates for farmers. The technology is not only helping in uplifting water from the wells for irrigation purposes, but is also replacing diesel-based water pumping systems. The portability of the solar system makes it easy and convenient to use on multiple farms.

Provision of weather based agro-advisory services through ICT: Agro-advisory services are being provided to 1,412 farmer households through one SMS and two voice calls a day. The advisory information contains weather forecast for 72 hours, and crop specific advisories based on a crop calendar prepared in consultation with farmers, local NGO staff, and local government agencies. Considering the limited access to mobile phones for women farmers, these messages are also communicated daily by writing them on the village notice boards. Messages are also customized for the need of women farmers based on their role and responsibilities in agriculture.

Improving farmers' access to weather-based insurance programme: Farmers in the CSV locations are linked to the Pradhan Mantri Fasal Bima Yojana (PMFBY). It provides insurance coverage and financial support to farmers in the event of crop losses as a result of natural calamities, pests, and diseases to stabilize the income of farmers and to encourage them to adopt modern agricultural practices. Given the low levels of awareness and enrolment in the insurance programme, several camps were organized in all 25 project villages to enroll Super-Champion, Champion, CSA and other farmers.

The project is also undertaking horizontal scaling of CSA activities across village communities through multiple methods.

Farmer-to-farmer: Non-beneficiary farmers are regularly invited to visit the fields of the Super-Champion, Champion and CSA farmers to learn about the application of CSA technologies and practices in different crop and livestock production systems. A 'Farmers Fair' also called 'Kisan Mela' was organized to spread awareness about climate-resilient technologies in agriculture and to promote face-to-face interactions among the farmers visiting from different parts of the district.

Private sector involvement: The project has collaborated with private players, such as IFFCO Kisan Sanchar Ltd. (ICT service provider), and established Farmer Producer Organizations to increase their involvement and contribution to CSA activities, and spread their services beyond the CSV project.

Convergence with government schemes: To take advantage of the multiple social schemes by the State and Central Government, the project is also converging some of its resources with those of other local government schemes to attain maximum impact among the beneficiary households. These include schemes relating to sanitation, health, drinking water and fuel. The project has managed to benefit 1,591 beneficiary households.

Source: *Chanana et al. 2018.*

Tools

Tool 1

Gender and Climate Change Research Tools

There are a number of tools that can be used to support research on gender and climate change. The tools can be used to gather data and information on different issues. Here, the tools are roughly grouped under three headings.

Table 11: Ten gender and climate change research tools

Climate analogue tools	Objectives
» Village resources map » Seasonal calendar » Daily activity clocks » Farming systems diagram » Capacity and vulnerability analysis matrix	» To better understand how, and if, different vulnerable groups exchange knowledge with others, the distances villagers travel, with which villages they interact with, and why they have chosen to interact with these. » To explore if, and how, the climate analogue approach might include gender dimensions of analogues (as well as similar cultures, languages, resource access, for example) that goes beyond similarities of local climates that the analogue principle is based on.
Weather forecast tool	Objectives
» Seasonal food security calendar	» To better understand the types of weather, climate and agricultural information, such as daily and seasonal weather forecasts, available to rural women in comparison to men, and their ability to use that information. » To understand the opportunities and constraints in accessing and using climate information. » To understand the degree of intra-household sharing of climate information.
Tools for understanding and catalyzing gender-sensitive climate smart agriculture initiatives	Objectives
» Venn diagram » Institutional profiles » Changing farming practices	» To understand gender differences in access to climate smart agricultural interventions and opportunities by exploring institutional arrangements. » To provide information supporting improved access to information and benefits linked to climate change-related interventions. » To map ongoing farming practices, both climate smart and conventional farming practices, as a means to determine how to foster climate smart agricultural practices.

Source: *FAO and CCAFS 2013*

Tool 2

Criteria for evaluating gender-responsive approach in CSA-sensitive practices

Table 12: Criteria for evaluating gender-responsive approach in CSA-sensitive practices

Criteria	Explanation of criteria
Both development and application of climate smart practices have been informed by gender analysis	**Gender analysis:** To better understand the site specific gender, cultural, social and economic context we must analyse who has what and why, who does what and why, who makes decisions and why, and who needs what and why, right at the start of developing a climate smart intervention/introducing a practice. This analysis explores the differential vulnerability of men and women to risk, their opportunities and benefits, the existing power relations within the household and the community, their willingness to take on risk, and available modes of access to sources of information. Findings of this analysis inform the application of the practice. *For additional guidance on carrying out gender analysis in the context of climate change and agriculture, see FAO and CCAFS 2013.*

All practice-related work involves equal participation and engagement of men and women, particularly those who implement the climate smart practice	**Participation and engagement:** Female and male farmers must be equally involved in developing, adapting, testing and adjusting climate smart practices to meet their needs, preferences, and opportunities. Communities and experts work together to understand local problems, climate projections, and available assets and services, and to identify and test potential solutions by reducing existing gender inequalities and discrimination. Institutions must also be strengthened if they are to continue fostering stakeholder engagement and raise their commitment towards gender equality and women's empowerment. It is also essential to involve both women and men from the first identification of the intervention all through to implementation, as well as in monitoring and evaluation, to assess the gender-related consequences and to introduce corrective actions if required. This helps avoid exacerbating existing inequalities and discrimination against certain social and economic groups. *For additional guidance on promoting participation in the context of climate change, see: CARE. 2009. Climate vulnerability and capacity analysis handbook.*
Efforts to reduce constraints to uptake of the climate smart practice	**Constraints to adoption of climate smart practices are adequately addressed:** Analysis findings are used to understand constraints to women's adoption of the practice, such as the unequal roles in decision-making, uneven access to information or credit, limited land ownership or other restrictions to resources and services needed for the practice or technology. By promoting equal access to resources and participation in household decision-making, all potential end users can benefit from information and capacity development related to the climate smart practice.
The practice results in short-term benefits for men and women	**Short-term benefits:** The climate smart practice is designed to produce benefits for both women and men. These benefits include improvements in agricultural yields; reduction in time, energy and labour spent by food producers, particularly women, on their agricultural activities; and increases in women's access to, and control of, agricultural inputs and income.
The practice results in Long term benefits for men and women	**Long term benefits:** The climate smart practice itself contributes to longer term changes in equality between men and women. It may enhance their specific resilience and agricultural productivity; increase women's control of resources and participation rates of women, youth and other marginalized groups in decision-making at household and community levels.

Source: *FAO and CCAFS 2016*

Tool 3

Checklist for Gender Issues in Climate Change Adaptation

Table 13: Checklist for Gender Issues in Climate Change Adaptation

No.	Description/Checklist	Yes	No	Remarks
1.	Has a mapping been done to understand the gender specific issues that may arise out of disaster and climate change?			
2.	Has a systematic gender analysis been carried out for different roles, responsibilities and socio-economic status of men, women and other household members?			
3.	Does the analysis include a focus on diversity issues, such as the situation of men and women who are poorer, ethnic minorities, elderly, disabled, etc.?			
4.	Are there gender sensitisation programmes conducted for local government officials and community leaders to fully involve women and men, as well as marginalised groups, in disaster risk management activities and decision-making?			
5.	Have activities been undertaken to strengthen both male and female capacity in activities such as risk mapping so as to enable gender perspectives of risks and vulnerabilities to be identified through processes such as VCA?			
6.	Do the decision-making processes of Community Based DRR and preparedness activities promote proportional representation of women and men from diverse groups?			
7.	Do local organisations participate in the promotion, planning or implementation of the programme?			

8. Do men and women fully participate in the risk analysis and in developing community-based early warning systems that use the local tools and knowledge of both men and women?

9. Do both genders actively engage in community-based early warning systems in order to ensure that procedures are sensitive to both female and male needs?

10. Are safety net cash transfers for household food security and basic needs provided directly to women?

11. Do women and men both have access to appropriate credit facilities and training for adapting their livelihoods to changing conditions?

12. Are women and men both involved in the development of land-use policies?

Source: *DMD & UNDP 2017*

Exercises

Exercise 1

To start introducing gender issues, think about common proverbs and sayings and how they can affect gender relations. For example, you could refer to the proverb: *A family is like a forest. When you are outside, it is dense. When you are inside, you see that every tree has its place*. How does this proverb relate to gender roles in a household or a community? (Source: FAO & World Bank 2017.)

Exercise 2

1. Ask the participants to list the tasks needed to produce a crop or livestock type in the area. For crops, this will include everything from obtaining seed and other inputs and preparing the land to sowing, weeding, controlling pests and disease, harvesting, threshing, drying, storage and sale. For livestock, it might include purchasing or breeding animals, care of pregnant and young animals, feeding, watering, herding, maintaining fences and hygienic shelter, milking, sale of milk and other livestock-derived products, and sale of animals.
2. Ask who generally performs each task: men, women, or both. Fill in a table like Table 14 below to show this.

Table 14: Who does what?

Task	Men	Women	Both
1.			
2.			
3.			

3. Now divide the participants into six small groups, and ask each one to discuss one of these topics:
   - Land and water;
   - Productive resources: farm equipment, tools, livestock;
   - Knowledge and technology;
   - Financial resources;
   - Access to decision-making;
   - Services and markets.

Each group should identify:

- Whether men or women or both have access to the resource/service or can use it? Who makes the decisions? For example, under financial resources, who can obtain credit? Who decides how to spend money?
- How will climate change affect the resource? Will it affect men and women differently? For example, under land and water, climate change may make the water table fall. Men may be affected because they are responsible for watering the crops. Women may be affected because they will have to go farther to fetch

water for domestic use. If they have to travel farther do they face dangers? Will the additional time they take for daily water fetching have consequences for other household members, such as girls taken out of school to fill in on domestic duties?

- Given existing levels of access to resources and services, as well as possible impacts of climate change, what is the possibility that men and women will adopt a climate-smart practice? An example of a specific practice could be given to the group for the purposes of discussion. For example, do women and men have access to the water resources needed to use this practice, and are those water resources likely to remain available under shifting climate conditions? If not, what would need to change for women and men to be able to adopt the practice?

4. Ask them to report back to the plenary. Based on their responses, fill in Table 15 on a series of flip chart sheets.

Table 15: Effect of climate change on women and men

	Access and control		Effect of climate change		Potential for adopting climate smart practice
	Who has access to the resource?	Who makes the decisions?	...on women	...on men	Men / Women
Land and water					
Productive resources: farm equipment, tools, livestock					
Knowledge and technology					
Financial resources					
Access to decision-making					
Services and markets					

Source: *FAO 2018*

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Unit VI:
Technologies for CSA

Objectives

- Elucidate various technologies in CSA

Introduction

Developing technologies to combat the effects of changing climate is most imperative to meet the needs of farmers in the agricultural sector. Climate smart agriculture interventions are built on three pillars which include sustainably increasing productivity, building resilience of livelihoods and the ecosystem, and reducing greenhouse gas emissions. Interventions can range from the implementation of new practices or changes in current agronomic practices, to the introduction of new information products, such as seasonal climate forecasts. Climate smart technologies and practices address the challenge of how to transition to a climate smart agriculture (CSA) on a large scale for enabling transformation and reorientation in agricultural systems to support food security under the new realities of climate change. EAS should facilitate the sustainable stewardship of natural resources and mitigate the risks of overproduction, deforestation and depletion of water resources. This unit helps to improve their understanding with the aim of providing better services to farmers so that the latter get acquaint with the best technologies in climate smart agriculture.

Discussion

'Climate Smart Agriculture' is the collective name for solutions and technologies contributing to climate mitigation or adaptation in agricultural practice. The set of technologies should improve the use efficiency of water, fertilizer, pesticides and natural resources by imparting resilience to farming.

There are many technologies available or in development, but not exploited to their full extent.

Sustainable Agricultural Productivity for Food Security

CSA works on the principle of sustainably increasing agricultural productivity and incomes from crops, livestock and fish, without having a negative impact on the environment. Most of the practices prevent soil damage that releases carbon and water into the atmosphere, promote soil and water conservation, and increase productivity (See Table 16).

Sustainable intensification is an approach to increase food production from existing farmlands in ways that place far less pressure on the environment and that do not undermine our capacity to continue producing food in the future.

Source: *Garnett et al. 2013*

Strengthen resilience to climate change through 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. Farmers need to produce enough food to eat and then a surplus to sell for their livelihood even if the season is hot, cool, wet, or dry. In some places there is high rainfall and in some places erratic rainfall. Farmers need to adapt to climate change shocks by adopting strategies that help them maximise their agricultural productivity even in the period of adverse climate events (See Table 17).

There are three variables that can be modified at local levels and within communities to reduce the vulnerability of farm systems (FAO 2018):

Table 16: Description of some sustainable agricultural practices	
Zero-tillage or no-tillage	Exposing the soil only where the seeds are placed, with minimal soil disturbance and retention of plant residues on surface.
Adoption of nitrogen efficient crop varieties	Increases agricultural productivity and minimizes nitrogen losses from the soil. Example: varieties that use nitrogen more efficiently will lead to global yield increase for rice.
Adoption of drought- and heat-tolerant crop variety cultivation	Specifically designed to resist certain climate-related challenges, like droughts, floods, saline or acidic soils, and pests.
Improved feed management	Storing fodder, such as stover, legumes, grass and grain, and making better use of feed by combining types; growing grass varieties specifically suited to the agro-ecological zone.
Livestock manure management	The collection and storage of livestock manure for future application to producers' fields. It dries and composts during storage.
Water harvesting irrigation	Collects water from a surface area for irrigation or for improved filtration. These systems can be small or large, ranging from individual farms and plots to a much more extensive area. Structures can include open water ditches and water pans that must be managed well so as to avoid insects' proliferation, as well as closed tanks and cisterns.
Drip irrigation	A form of irrigation that allows water to drip slowly to the roots of many different plants thanks to a network of pipes, tubing and emitters. Narrow tubes deliver water directly to the base of the plant. It saves water and fertilizers.

***Source:** World Bank, FAO and IFAD 2015*

- Reduce the farm system's exposure. Planting healthy windbreaks and hedgerows and following no-tillage planting practices help soil to stay put and resist erosion. Storing feed off the ground helps keep it safe from floods and vermin.

- Reduce the sensitivity of farm systems to these shocks. Using drought-resistant varieties or keeping adequate stocks of hay can reduce sensitivity to drought. Water harvesting, storage and conservation apply management techniques to reduce runoff and balance supply against demand.

- Increasing adaptive capacity involves learning new skills and trying innovative solutions. This includes considering the modifications of a system and taking into account all the potential shocks and changes together as possible compensating, exacerbating and aggregating effects.

Table 17: Examples for adaptation to climate change at farm level

Risk	Response
Changing climate conditions and climate variability and seasonality	» Optimize planting schedules such as sowing dates (including for feed stocks and forage); » Plant different varieties, species or cultivars of crops; » Use short duration cultivars; » Varieties or breeds with different environmental advantages may be required, or those with broader environmental tolerances: use of currently neglected or rare crops and breeds should be considered; » Early sowing can be enabled by improvements in sowing machinery or dry sowing techniques; » Increased diversification of varieties or crops can hedge against risk of individual crop failure; » Practice intercropping; » Make use of integrated systems involving livestock and/or aquaculture to improve resilience; » Change post-harvest practices, for example, the extent to which grain may require drying and how products are stored after harvest; » Consider the effect of new weather patterns on the health and well-being of agricultural workers.
Change in rainfall and water availability	» Change irrigation practices; » Adopt enhanced soil water conservation measures; » Use marginal and waste water resources; » Make more use of rainwater harvesting and capture; » In some areas, increased precipitation may allow irrigated or rain-fed agriculture in places where previously it was not possible; » Alter agronomic practices; » Reduce tillage to reduce water loss; » Incorporate manures and compost, and other practices such as cover cropping to increase soil organic matter and thus improve water retention.
Increased frequencies of droughts, storms, floods, wildfire events, sea level rise	» General water conservation measures are particularly valuable at times of drought; » Use flood, drought and/or saline resistant varieties; » Improve drainage, improve soil organic matter content and farm design to avoid soil loss and gullying; » Consider (where possible) increasing insurance cover against extreme events.
Pest, weed and diseases, disruption of pollinator ecosystem services	» Use expertise in coping with existing pests and diseases; » Build on natural regulation and strengthen ecosystem services.

Source: *FAO 2016*

Reduce Greenhouse Gas Emissions through Mitigation

Agriculture is one of the main sources of greenhouse gas emissions contributing mainly through crop and livestock management as well as through deforestation and degradation. There is more than one way to reduce agricultural greenhouse gas emissions.

Reducing emission intensity through sustainable intensification is one key strategy for agricultural mitigation. The process involves implementation of new practices that enhance the efficiency of input use so that the increase in agricultural output is greater than the increase in emissions. Increasing the carbon-sequestration capacity of agriculture is another way to reduce emissions. Plants and soils have the capacity to remove carbon dioxide from the atmosphere and store it in their biomass – this is the process of carbon sequestration. Increasing tree cover in crop and livestock systems (e.g., through agro-forestry) and reducing soil disturbance (e.g., through reduced tillage) are two means of sequestering carbon in agricultural systems. However, this form of emissions reduction may not be permanent – if the trees are cut or the soil ploughed, the stored carbon dioxide is released. Despite these challenges, increasing carbon sequestration represents a huge potential source of mitigation, especially since the agricultural practices that generate sequestration are also important for adaptation and food security (FAO & CCAFS n.d.).

Wherever and whenever possible, CSA should help to reduce and/or remove greenhouse gas (GHG) emissions. This implies that we reduce emissions for each calorie or kilo of food, fibre and fuel that we produce. This way we can avoid deforestation as well as manage soil and trees in many ways that maximizes their potential to act as carbon sinks and absorb carbon dioxide from the atmosphere (See Table 18).

Table 18: Examples of food security, adaptation and mitigation synergies

	Examples of possible Climate smart agricultural practices	Expected impact on food security	Possible impact on adaptation	Possible impact on mitigation
» Crops	» Improved land management practices such as reduced or zero tillage; » Improved agronomic practices; » Soil and water conservation measures; » Integrated nutrient management, such as efficient fertilizer application based on crop and site, specific nutrient balance analysis, split application, adaptable timing; » Proper management of organic soils avoiding deep drainage and deep ploughing, row crops and tubers and maintaining a shallower water table.	» Better plant nutrient content, increased water retention capacity and better soil structure generate tangible on-site production benefits in the form of higher crop yields.	» Increased system viability and resilience of crops and livestock; » Reduced vulnerability of farm system.	» Farming practices that restore soil health and fertility can increase biomass and carbon sequestration; » Conservation tillage minimizes soil disturbance and related soil carbon losses; » Integrated nutrient management reduces leaching and volatile losses; Proper management of organic soils reduces N2O and CH4 emissions; Reducing post-harvest food losses contribute to lower emissions per unit of food consumed.
» Livestock	» Improved feeding practices such as introducing highly digestible forages; » Improved genetics and reproduction, and animal health control as well as general improvements in animal husbandry; » Improved manure management; » More efficient crop and grazing land management such as rotational grazing.	» Increased animal productivity and production; » Increased nutrient cycling and plant productivity; » Improved fodder production.	» Increased system resilience and reduced vulnerability.	» GHG emissions in the livestock sector can be reduced substantially through improvement of feed quality, animal health and husbandry, more efficient energy use and manure management; » Reducing post-harvest food losses reduces emissions per unit of food consumed.

» Fishery and » aquaculture	» Use of fishing practices that adhere to the principles of the Code of Conduct for Responsible Fisheries; » Adoption of improved aquaculture management approaches such as selection of suitable stock, improved energy efficiency, increasing feeding efficiency, reduce losses from diseases; » Integration of aquaculture with other production systems such as aquaponics; » Improved management of ecosystems such as mangrove systems and seaweed farms.	» Increased fish productivity in a sustainable way; » More nutritional diets.	» Increased aquaculture resilience; » Increased resilience of natural ecosystems, increased biodiversity.	» More efficient energy use such as better use of fuel in capture fishing would reduce GHG emissions; » Increase the efficiency of feed and fertilizers. » Reducing post-harvest food losses reduces emissions per unit of food consumed.
» Agroforestry	» Use of trees and shrubs in agricultural farming systems: improved fallows, growing multipurpose trees and shrubs, boundary planting, farm woodlots, plantation/ crop combinations, shelterbelts, windbreaks, conservation hedges, fodder banks, live fences, trees on pasture, and tree apiculture.	» Increased farm incomes and diversified production with food security benefits.	» Reduced erosion, increased soil stabilization and H2O infiltration rates, land degradation halts, reduced vulnerability to shocks, increased resilience.	» Stores carbon in above and below ground biomass, and progressively increases organic matter and carbon stocks in the soil; » Agroforestry systems tend to sequester much greater quantities of carbon than agricultural systems without trees. » Agroforestry measures increase C storage and also reduce soil C losses stemming from erosion.

Source: *FAO, 2012; FAO 2013; Branca et al. 2012.*

A one-stop-shop compiled in the format of a compendium for CSA technologies, practices and services would therefore serve a guide for all the stakeholders for promoting CSA in smallholder systems. A compendium on Climate-Smart Agriculture (CSA) for Odisha, India is developed based on the workshop on 'Scaling Climate-Smart Agriculture in Odisha' organized at Bhubaneswar on 18-19 July 2018 by International Rice Research Institute (IRRI) in collaboration with Department of Agriculture (DoA) & Farmers' Empowerment, Indian Council of Agricultural Research-National Rice Research Institute (ICAR-NRRI), Orissa University of Agriculture and Technology (OUAT) & International Maize and Wheat Improvement Center (CIMMYT) under the aegis of CGIAR Research program on Climate Change, Agriculture and Food Security (CCAFS). They are not only a tool for farmers and decision-makers, but are also the main conduit through which CSA practices can be scaled up and sustained (see box below).

A compendium of Technologies, Practices, Services and Policies for Scaling Climate Smart Agriculture in Odisha (India) by Sharma S, Rana DS, Jat ML, Biswal S, Arun KC and Pathak H (2019).

This compendium brings together a collection of experiences from different stakeholders with background of agricultural extension and rural advisory services in supporting

CSA. The contributions are not intended to be state-of-the art academic articles but thought and discussion pieces of work in progress. The compendium itself is a 'living' document which is intended to be revised periodically. The approaches and tools available in the compendium span from face-to-face technician farmer dialogues to more structured exchanges of online and offline e-learning. In every scenario it is clear that tailoring to local expectations and needs is key. In particular, the voice of farmers is essential to be captured as they are the key actors to promote sustainable agriculture, and their issues need to be prioritized. The compendium includes:

1. TECHNOLOGIES & PRACTICES

1. Stress tolerant varieties impart resilience to farmers in flood-prone areas – S. Biswal (OUAT), and D.S. Rana (IRRI).
2. Lodging resistant paddy cultivar in cyclone and heavy rainfall situations – S. Biswal, T. Panigrahi (OUAT)
3. Non puddled transplanting rice (NPTR) –a resource saving approach – S. Biswal,
4. Jyotiprakash Mishra (OUAT)
5. Diversification with green gram and groundnut for resource conservation – S. Biswal, T. Panigrahi (OUAT)
6. Climate smart adaptation packages -S Nedumaran, Kadiyala M. D. M, Roberto Valdivia and Anthony Whitbread (ICRISAT)
7. Stress-resilient maize hybrids for droughtprone environment - P.H. Zaidi (CIMMYT) System of Crop Intensification adopted in Rice and Finger Millet - Prabhakar Adhikari and Luna Panda (PRAGATI)
8. Drought tolerance and high yielding fodder varieties, hydroponic fodder cultivation and processing and storage of feed and fodder - Braja Bandhu Swain and H Rahman (ILRI)
9. Improved maize production practices for plateau ecology of Odisha – Nabakishore Parida, Wasim Iftikar, Anurag Ajay, R K Malik & A McDonald (CIMMYT)
10. Direct seeded rice (DSR) for better resource management - S. Biswal (OUAT), D. S. Rana (IRRI)
11. Alternate Wetting Drying (AWD) for saving water and labour - S. Biswal (OUAT), D.S. Rana (IRRI)

12. Intensifying rice fallows with green gram var. IPM 02-14 - S. Biswal, T. Panigrah (OUAT)
13. Integrating weed management (IWM) technology for higher productivity- Sanjoy Saha (ICAR-NRRI), S. Biswal (OUAT)
14. Field-specific nutrient management for rainfed rice through Rice Crop Manager (RCM) - Sheetal Sharma and Rajeev Padbhushan (IRRI)
15. Solar Power as a Remunerative Way to Minimize Climate Risks - Arun KhatriChhetri (BISA-CIMMYT) and Tushar Sahah (IWMI)
16. Climate resilient rice varieties for risk reduction and sustainability in stress prone area - Swati Nayak, Mosharaf Hossain, Mukund Variar (IRRI)
17. Solar powered irrigation system – Paresh Bhaskar (BISA-CIMMYT)
18. Residues management for improving soil health and yield enhancement - S. Biswal (OUAT), D.S. Rana (IRRI)
19. Solar power - a potential source to minimize climate risks - S. Biswal (OUAT)
20. Mechanization of farming for tackling labour scarcity - S. Biswal (OUAT), D.S. Rana (IRRI).

2. SERVICES

1. Weather-based advisories for groundnut - AVR Kesava Rao, Suhas P Wani, Sreenath Dixit and K Srinivas (ICRISAT)
2. Reaching farmers with context specific and actionable agro-advisories: The Intelligent Systems Advisory Tool (ISAT) - Dakshina Murthy Kadiyala, KPC Rao, Ram Dhulipala, Mithun Das Gupta, Soudamini Sreepada and Anthony Whitbread (ICRISAT)
3. Science-based crop insurance system for increasing farmes' resilience - T.D. Setiyono, D. Murugesan, A. Maunahan, E.D. Quicho, M. Variar, J. Singh, P. Kumar, A.K. Pradhan, H.A. Pramanik and S. Khanda (IRRI).

3. TARGETING

1. Coastal flood prone zone identification for timely establishment of paddy - Amit Kumar Srivastava, Balwinder Singh, (CIMMYT)
2. Targeting rice-fallows: A cropping systembased extrapolation domain approach - P.K. Yeggina, M. Variar, D.D. Sinha, P.K. Dhal, A. Kar, S. Sahoo and T.D. Setiyono (IRRI).

4. BUSINESS MODEL

1. Rice nursery enterprise model - Bidhan Mohapatra, Prakashan Chellattan Veettil, P.Panneerselvam, and Sudhanshu Singh (IRRI)
2. Women-led informal seed production and distribution of climate resilient rice varieties - Swati Nayak, Rohini Ram Mohan, Ranjitha Puskur (IRRI)
3. Community mat nursery: ensuring availability of paddy seedlings under contingent situations - S. Biswal, T. Panigrahi (OUAT).

5. CAPACITY BUILDING

1. Creating a standardized knowledge platforms for institutional capacity development - Poornima Shankar, Shakti Prakash Nayak and Noel Magor (IRRI)
2. Village level seed training to combat seed shortages in groundnut - S. Biswal, T. Panigrahi (OUAT)
3. Increasing capacity of grass root level extension workers in using ICT based tools - Sheetal Sharma and Preeti Bharti (IRRI).

6. POLICY

1. Climate Smart Agriculture Village Policy for Odisha - Barun Deb Pal (IFPRI)
2. Intensifying Rice Fallows with Pulse crops in Odisha - Kaushal Garg, Girish Chander, Arabinda K Padhee and Sreenath Dixit (ICRISAT)
3. Climate-Smart Villages: Bundling of CSA technologies, practices and services - Arun Khatri-Chhetri and Pramod Aggarwal (BISA-CIMMYT).

Link to the compendium:

https://cgspace.cgiar.org/bitstream/handle/10568/106888/http://CSA_Odisha_Compendium_web.pdf

Conclusion

This unit introduced different climate smart technologies and practices to attain the three objectives of CSA. This will support EAS in providing better services to farmers by promoting local climate smart practices to adapt and mitigate climate change.

Cases

Case 7: Weather-based agricultural advice boosts crop and livestock production in India

Nearly 70 years ago, All India Radio started broadcasting a weather bulletin for farmers. These bulletins and the subsequent TV show, Krishi Darshan, played a vital part in promoting the uptake of improved production technologies by smallholder farmers, thus enabling them to respond to demands imposed by the weather.

Such advisory services have come a long way. The latest iteration, the Integrated Agro-Meteorological Advisory Service (IAAS) was introduced in 2007. The service involves a wide range of partners, including the India Meteorological Department (IMD), the National Centre for Medium Range Weather Forecasting (NCMRWF), the Indian Council for Agricultural Research (ICAR), State departments of agriculture and agriculture universities, several government ministries, media organisations, non-governmental organisations, and private sector bodies.

The meteorological services provide weather data and five-day forecasts. Specialists from ICAR, State departments of agriculture and the universities translate these into agricultural advisories, to alert farmers to weather-related events that are likely to affect their agricultural operations, such as strong winds, low temperatures or periods of humid weather, which can increase the risk of disease outbreaks. They also provide advice on what actions farmers should take. Field units at the agriculture universities relay these advisories to farmers in local languages using a variety of channels, including SMS messages on mobile phones, local radio and newspapers, and face-to-face advisory and extension services.

The IAAS also provides national-level and state-level advisory bulletins, used for planning by national and State governments and the agro-input supply industry.

The agricultural advisories currently reach some 2.5 million smallholder farmers across India. Studies have shown that farmers receiving IAAS advisories have yields that are 10–15% higher, and costs that are 2–5% lower, than farmers not receiving the advisories, largely as a result of using more modern agricultural production technologies and practices, having better irrigation and pest/disease management, and improved post-harvest technologies. Since it started in 2007, the service has had an estimated economic impact of more than USD 10 billion.

The IAAS has clearly helped farmers cope with current, short-term, climate-induced risk, but may be able to do little to help them adapt to longer-term climate change. More needs to be done, to build on the foundation of farmer engagement and to help farmers make the changes necessary to cope with uncertain future climate scenarios.

Source: *CCAFS and CTA 2013*

Case 8: Food-tolerant rice varieties in India and Bangladesh

Bangladesh and India are the two most vulnerable areas to climate change in South Asia. During floods, farmers in Bangladesh and India lose up to 4 million tons of rice per year — enough to feed 30 million people. Submergence can affect rice crops at any stage of growth, either short-term (flash floods) or long-term (stagnant flooding). Chances of plant survival are extremely low when completely submerged during the crop's vegetative stage. During flooding, the rice plant elongates its leaves and stems to escape submergence, but high-yielding modern varieties cannot elongate enough. If floods last for more than a few days, the rice plants expend so much energy trying to escape that they are unable to recover.

Plant breeders have discovered that a single gene, the SUB1 gene, confers resistance to submergence of up to 14 days. Scientists were able to isolate this gene, derived from an Indian rice variety, and identify the genetic code that controls submergence tolerance. The SUB1A gene activates when the plant is submerged, making it dormant, thus conserving its energy until the floodwater recedes. Improved varieties incorporated with the SUB1 gene have shown a yield advantage of 1–3 tons following flooding for 10–15 days. The project Stress-Tolerant Rice for Africa and South Asia (STRASA) began at the end of 2007 when the International Rice Research Institute in collaboration with AfricaRice started to develop and deliver rice varieties tolerant to abiotic stresses to millions of farmers in unfavourable rice-growing environments. Flood-tolerant varieties that have been released through STRASA and are now being planted include Swarna Sub1 in India and Samba Mahsuri in Bangladesh.

Relationship to CSA

Worsening floods are among the most established impacts of climate change in many rice growing regions. East India and Bangladesh have been battered by several tropical cyclones in recent years. Increasing sea levels will further raise flooding risks in coastal areas and deltas. In addition to water depth, higher sea levels increase the duration of flooding which is typically the decisive feature that determines the survival rate of rice plants. Flood-tolerant rice varieties are effectively the only adaptation option available under such hazardous circumstances of intense flooding events. One impact assessment study showed that SUB1 can deliver both efficiency gains, through higher and less variable yields; and equity gains in disproportionately benefiting marginal, lower caste groups of farmers heavily occupying these areas.

Impact and lessons learned

Plant breeding has a long track record of improving resilience of rice production systems to climatic extremes. New approaches of (non-GMO) 'precision breeding' allow the introgression of specific traits into any given variety while its 'genetic background' remains largely intact. In turn, the new version of this variety will not need any change in crop management and will also maintain the grain quality traits. By choosing popular varieties for genetic improvement, this approach will not face any problem apropos farmers' acceptability of improved seeds.

Link Source: *https://csa.guide/csa/467*

Case 9: Digital Green: Participatory video as a promising tool for extension in the field of CSA

Digital Green, an independent non-profit organization is adapting and scaling its approach in order to engage more than 800,000 farmers (80% of them women) across India, Ethiopia, Afghanistan, Ghana, Niger, Papua New Guinea and Tanzania. Digital Green uses a participatory approach to train extension agents and peer farmers to produce short videos featuring local farmers demonstrating improved agricultural practices or sharing testimonials using low-cost pocket video cameras, microphones and tripods. The videos are shown using mobile, battery-operated projectors among small groups of farmers. An extension agent or peer farmer facilitates a discussion among the group viewing the video and records data on farmer feedback, their questions and level of interest, and which practices they adopt. Data and feedback informs the production and distribution of the next set of videos in an iterative cycle that progressively better addresses the needs and interests of a community. In a controlled evaluation, the approach was found to be seven times more effective in terms of adoption of new practices and ten times more effective on a cost-per-adoption basis (Gandhi et al. 2009).

Participatory video is the core delivery mechanism for Digital Green's approach; however, Digital Green also uses other communication channels, such as broadcast television, radio and mobile applications and IVR, to disseminate and reinforce extension messaging and link farmers to markets. Digital Green has found that different modes of communication can complement one another across the awareness-knowledge-adoption productivity continuum of agricultural extension. Farmers are most open to information when it comes from sources similar to themselves in contexts with which they can identify. Digital Green is also using videos to build curricula that are incorporated into the training regimes of extension agents.

Climate Smart Agriculture

Digital Green's model promotes the adoption of climate smart agriculture (CSA) practice in India and Africa, having the effect of sustainably increasing agricultural productivity and incomes. Most of the content of the videos produced and disseminated to farmers is focused on boosting farm productivity with improvements in farm management and agronomic practices, rather than the 'technology transfer' of traditional extension, which often focuses on supplying improved inputs, including harmful synthetic pesticides and fertilizers. It also reduces the cost and increases resilience of farmers, reducing their risk to climate and market shocks. The focus is on taking advantage of locally available, endogenous knowledge and resources, and those that show the strongest control on yield, including water, soil management and pest management (Hengsdijk & Langeveld 2009).

The Government of India's National Rural Livelihood Mission (NRLM), for instance, is leveraging Digital Green's approach to promote the adoption of improved rice production practices, including seed nursery raising and transplantation in paddy cultivation, weeding and water management, and seed treatment. These practices follow the government-approved environmental guidelines, which include pest management, disease management, soil nutrient management, cropping patterns in rainfed areas, and soil and moisture conservation. Following these guidelines is an important part of Digital Green's approach to work with existing systems since setting up parallel systems limits the long term viability of the approach.

In addition to rice, Digital Green promotes practices to improve productivity in teff in Ethiopia, wheat in India, pulses, oilseeds, and vegetables. This includes methods to enable farmers to apply fewer seeds, grade and treat seeds, sow with wider spacing, use organic manuring, intercropping, optimizing water management, and using organic fertilizers and pesticides. This approach reduces the consumption of chemical inputs and water, increases overall agronomic productivity, and increases farmers' resilience and incomes. Promoting yield-boosting practices lies in the farmers' natural interests and they are also less harmful to soil and the surrounding environment. Rather than convincing farmers to adopt complex practices that require additional, sometimes costly inputs, the content of Digital Green practices rely on endogenous knowledge that is relevant in the local context.

In addition to the practices themselves, the Digital Green approach to improving agriculture extension also helps to promote CSA. For instance, videos feature local individuals and contexts that viewers are able to relate to, and then are encouraged to adopt new practices, increasing their skills and experience with adaptation. Videos feature a variety of different farmers in different conditions adapting and applying practices, which is critical with increased climate variability. Self-efficacy among farmers is often increased as they see peers as role models whom they can aspire to become (Bernard et al. 2014), in part by adopting new practices and realizing the benefits to themselves and their families. Perceptions of risk are reduced by seeing farmers apply practices from start to finish. The videos also provide insight on how to access products, services and resources that might be needed to take action on them. Data collected and feedback at an individual level helps to identify weather, pest, disease constraints or other climate issues that may be an effect of climate change. These data can add insight to climate variability in different regions, show how climate patterns affect some farmers more than others, and allow for better targeting of extension programmes.

The approach includes a robust data collection and monitoring system that enables governments to track the adoption of new practices. Thus governments can implement and track the implementation of CSA practices. Digital Green developed an open-source data management system, called Connect Online Connect Offline (COCO) (Shah and Joshi 2010) to collect information related to the adoption of improved practices. Extension agents, for example, can access the system on and offline to easily and accurately enter data about video screenings, interest and questions from farmers, and adoption of technologies promoted in the videos, providing feedback that informs future content. These data are publicly available on Digital Green's analytics dashboards (analytics.digitalgreen.org), videos library (digitalgreen.org/discover), and Farmerbook (farmerbook.digitalgreen.org) platforms to drive knowledge sharing and increase the accountability of extension through transparency. Digital Green has partnered with national agriculture research systems and international CGIAR centres, like IRRI and CIMMYT, to contribute technical input and review farmer feedback and adoption data to inform research agendas. Digital Green also used the data sets to conduct social network analyses to identify influencers and other factors that drive adoption on new practices among farming populations.

Lessons learned

Digital Green works with government partners to institutionalize the core components of the approach into permanent programming, providing opportunity for making CSA practices standard. Risks of the approach include shifting political dynamics that can affect CSA programming and the lack of technical expertise on climate smart practices. Working through government systems requires a reliance on existing staff capacity of extension workers and limited measures to ensure accountability. Digital Green is working to mitigate these risks by providing outside technical expertise to provide additional technical support, where needed, and using data and feedback at the level of individual extension agents to promote accountability.

Digital Green achieves scale through two channels: integration with host country systems, and the replication of the approach through partner organizations. Since the approach is integrated with government and private extension systems, it can be scaled up to work at additional locations and with a greater number of farmers with low incremental cost. In India, NRLM has invested considerably in supporting the expansion to more than 5,000 villages across the country through the purchase of equipment, compensating staff, and supporting training. As aspects of the approach (video production, dissemination, and data collection) become institutionalized, Digital Green's role shifts to one focused on providing technical assistance and overseeing quality assurance.

Digital Green's franchisee model enables replication of the approach, supporting public or private partner organizations to replicate it through (1) online and in-person training and accreditation on community facilitation, video production, and data management techniques via Digital Green's Virtual Training Institute (VTI); (2) access to Digital Green's open source technology stack, with technical assistance as needed; and (3) links to the content library and knowledge partners that are able to provide relevant inputs to franchisees. In addition to areas of current operations, Digital Green is expanding its model to Bangladesh and Malawi.

Source: *GACSA 2016*

Case 10: Farm Yield Improvement (Sugarcane) by DCM Shriram Limited

DCM Shriram Ltd (the 'company') started its sugar business in the central Indian State of Uttar Pradesh in 1997 and now operates four sugar mills with a total installed capacity of 33,000 tons crushed per day, crushing four million tons sourced from 150,000 smallholder farmers. The sugar production facilities also have co-generation power plants with installed capacity of 115 MW supplying energy to the national grid and meeting the company's captive power requirements.

The Challenge

Sugar mills need to run for at least 120-140 days in a year for optimal efficiency. Smallholder farmers in the company's sugarcane procurement area have low farm yields compared with sugarcane farmers in other parts of the state and the country. For instance, while the average sugarcane yield for Uttar Pradesh is 58 metric tons per hectare, for farmers in the company's sugarcane procurement area, the yield is just 45 metric tons per hectare. The average sugarcane yield for India is 65 metric tons per hectare, while the highest sugarcane yields in India are recorded in the State of Tamil Nadu at 100 metric tons per hectare. The low farm yields in the company's sugarcane procurement area increases the opportunity cost for cultivating sugarcane, leading to several farmers shifting to other commercial crops. For the company, this means a reduction in sugarcane available for sourcing, leading to a reduction in the number of days for mill crushing, and therefore, reduced plant capacity utilization.

There were several reasons for low and stagnant farm yields in the company's sugarcane procurement area. One of the prime reasons was low capacity and technical know-how in the smallholders cultivating sugarcane. Most of the farmers were practicing low-tech agriculture with unsustainable input usage, such as over-application of fertilizers and water (leading to an increase in the cost of cultivation without any commensurate increase in yields) and non-climate smart practices such as burning of crop residue and over-irrigation.

The Solution

In 2009, the company and the International Finance Corporation (IFC) developed a systematic programme for farmer training and capacity building for sustainable yield improvements through adoption of a climate smart sugarcane agronomy package of practices (PoP) named the 'Meetha Sona' programme, which translates to 'sweet gold'. Starting with 2,000 smallholders, the company introduced several training and capacity building measures for the extension workers and farmers. These included establishing demonstration farms for climate-smart sugarcane cultivation practices, such as new climate-resilient, high-yielding varieties; soil health improvement; water-use efficient practices and technologies such as mulching, furrow irrigation, land levelling, and drip irrigation systems; and an integrated pest management programme. With IFC's support, the company adopted an eight-step approach following the '3 S' principle of suitability, sustainability, and scalability, as depicted below.

Table 19: 8-Step Approach for Sustainable Yield Improvement

1.	**Need Assessment**	Identifying gaps/opportunities
		Baseline
2.	**Custom PoP**	Locally appropriate PoP, including water-use efficiency
3.	**Training Manual**	Good agronomy
		Extension support
		Improved varieties
		Farmer engagement criteria
		Do's/Don'ts
4.	**Capacity Building**	Training the trainer approach
		Classroom and on-field training & feedback
5.	**Lead Farmers**	Technology demonstration and exposure visits
		Farmer groups, mentorship
		Micro-entrepreneurship for mechanization
6.	**Farmer Training & Demonstrations**	Farmer training by extension workers
		In-field expert advisory
		Technology demonstration
7.	**Monitoring & Evaluation**	Field performance with crop cutting
		Farmer KABP (knowledge, attitudes, beliefs and practices) survey
		Cost-benefit analysis
8.	**Scale Up/Replication**	Development results
		Best practices/lessons

RESULTS

After three years of implementation, an independent, third-party assessment for the demonstration programme showed a 69% yield differential for the farmers in this programme farmers vis-à-vis the control group farmers. The company thereafter scaled up the initiative to cover 80,000 farmers, including 15,000 women farmers, and laborers surrounding its four sugar mills. As a result, there has been an increase of over 70% in the area under mulching where smallholders have shifted from stubble burning, thereby reducing greenhouse emissions from the farms while also improving soil water moisture and reducing demand for irrigation. Over 50% of Indian farmers grow sugarcane during autumn planting (September to October) along with pulses, oilseeds, green gram, and potatoes, a practice which not only promotes smart land use but also supplements farm incomes. Thirty-eight billion litres of water-use has been avoided on sugarcane farms due to smallholders adopting water use efficiency practices, such as mulching, land leveling, and furrow irrigation – a figure independently verified by EY.

With IFC's support, the company has partnered with several other interested institutions, such as Solidaridad Asia Ltd and Hindustan Unilever Foundation, to bolster its efforts to scale up. Today, the company is in Phase IV of the 'Meetha Sona' programme with support from an additional partner, Coca-Cola India Private Ltd, with the aim of further increasing farm yields by an additional 25 to 30% by 2020.

Conversely, the company also benefited from the 'Meetha Sona' programme. With increased availability of sugarcane in the area, the company was able to increase its procurement volume. From a baseline of 90-day milling operations in 2010, it has boosted productivity to 120 days of milling operations in a season, thereby improving its plant capacity utilization. There has also been a marked improvement in the quality of sugarcane, with sugar recovery improving over the last few years. From an average recovery of 9.27% in 2014-2015, sugar recovery has improved to over 10.01% in 2016-2017, which has in turn improved the company's top and bottom-line performance. Furthermore, sugar recovery is poised to increase to 10.50% in 2017-2018 due to acceleration in adoption of improved agronomic practices by farmers, and improvements in the 'cut-to-crush' time due to the streamlining of harvesting systems and processes.

Table 20: Climate Smart Agriculture Impact Summary

Type	Description	Impact to Date	Expected Impact by 2020
Smart land use	Increased output per unit of land (allowing land to be used for other crops); balanced land-use through inter-cropping; improved farmer income	Average 20% increase in yields and farmer income	15% yield increase
Water-use efficiency	Optimal use of water as per crop requirement; reduction in irrigation water requirement due to efficient practices and technologies	~55 billion litres of water use avoided on farms	20 billion litres of water use to be avoided
Greenhouse emission reductions	Reduced diesel pump usage (due to reduction in irrigation water demand); reduced stubble burning due to mulching	70% increase in area under mulching	100% of procurement from farms with no stubble burning

Source: *IFC 2017*

Case 11: Smart Land Use through Social Farm Forestry by JK Organization

Part of the 100-year-old JK Organization, JK Paper Ltd is one of India's leading paper manufacturers. It has two large integrated paper manufacturing units in Rayagada in Odisha and Songadh in Gujarat with a combined capacity of 455,000 metric tons per year. It is the market leader in India in the branded copier paper segment, and among the top two players in the country in coated paper and high end packaging boards.

The Challenge

While there is a growing demand for paper and paper products in India, there is a severe shortfall in the supply of wood pulp. Unlike other major paper manufacturing countries where paper companies own large tracts of designated forest lands to meet their wood pulp requirements, India does not allow paper companies to own tree plantations. Thus, paper companies depend on out-growers to plant trees. Given most farmers' reluctance to grow trees due to the relatively long gestation period from planting to harvest, many paper companies end up with wood supplies from a long distance away (sometimes as much as 600 kilometres away from the manufacturing units).

The business of paper manufacturing is critically influenced by logistics, as the most competitive companies are able to bring in wood pulp from closer locations, thereby keeping their transportation costs low. To stay competitive and to ensure a stable and consistent supply of plantation wood, the company decided to source all its wood requirements from less than 200 kilometres from its manufacturing units. However, both of its paper manufacturing units are in locations that are water-stressed, have degraded lands with stagnant agriculture, and resource-poor farmers. This difficult situation is further exacerbated due to climate change, as evident from the increased frequency of fluctuating weather conditions, recurring droughts, and a growing incidence of pests.

The Solution

The company has initiated an ambitious programme, called the Social Farm Forestry Programme, for promoting climate smart land use for out-growers within 200 kilometres of its paper manufacturing plants. It works with out-growers in proximity to its manufacturing units to grow the desired plantation wood (*Subabul*). This was considered an audacious move by most of the industry experts, as it is difficult to convince farmers to change their traditional crop-growing patterns. Fears were that farmers would never plant long gestation crops, they would be apprehensive about buyers, and that they would not shift from commercial crops, such as sugarcane and cotton. Under the Social Farm Forestry Programme, the company undertook several measures to educate and convince the farmers to shift from crops with a high environmental footprint (sugarcane, cotton) to trees (such as *subabul*). In the process, the company did the following:

Set up world-class research and development facilities at its paper manufacturing units to develop fast-growing clonal *subabul* varieties to reduce the time between planting and harvest;

Developed a cadre of trained extension employees to work with farmers and educate them on the benefits of shifting to tree plantations. This included educating them on farm economics. A number of farmers were organized in small farmer groups/cooperatives to work together to grow trees on a relatively larger scale as a unit;

Developed farms to demonstrate intercropping high-value, symbiotic crops with *subabul* so that farmers could improve their land use and supplement their incomes;

Provided a buy-back guarantee to all farmers growing clonal varieties of *subabul* to mitigate any marketing risks.

The company collaborated with IFC in 2008 to professionalize its Social Farm Forestry Programme, focusing attention on farmer training and capacity building, extension worker training, developing robust farm economics with trees and intercrops as appropriate for farmers, and facilitating access to financing for farmer cooperatives for tree plantations.

Results

What started as a trickle several years ago has now attracted more than 45,000 farmers across both

corporate locations, and the extent of coverage has increased from zero to an aggregate of over 150,000 hectares. The company has become a wood-positive company as it plants more trees than it consumes. Just when it looked like a local commercial agriculture solution would not take off, persuasion and persistence triggered a plantation revolution. The proportion of raw material procured locally by the Odisha facility increased from 25% to an estimated 60%. The sourcing radius has declined, and the bulk of the sourcing is now conducted within 200 kilometres from the manufacturing plant, easing up logistics and reducing operating costs (including fuel consumption). Improved raw material quality (clonal variety trees) has translated into increased manufacturing efficiency.

There have been several ecological and environmental benefits from the plantations under the Social Farm Forestry Programme:

Greening of wastelands and an increase in tree cover on degraded marginal lands. The company has encouraged an addition of 15,000 hectares annually to its plantation through the distribution of more than 60 million saplings to farmers, out of which 20 million saplings are produced in self-owned, high-tech, advanced clonal nurseries.

Improved micro-climate, lowering soil temperature, and a reduction in moisture evaporation through shading and mulching. Eradication of surface run-off, nutrient and soil erosion, and improvements in soil structure through the constant addition of organic matter.

Up to a 25% increase in farm incomes due to intercropping with clonal varieties of *subabul*.

An Emission Reduction Purchase Agreement (ERPA) was signed, covering 1,608 hectares, mainly owned by small and marginal farmers associated with the company's Social Farm Forestry Programme, providing additional income to participating farmers while shrinking their carbon footprint.

Table 21: Climate part practices and impact

Type	Description	Impact to Date
Smart land use	Conversion of wasteland and degraded lands to green cover; intercropping with trees provides enhanced income to farmers and fixes nutrients like nitrogen in the soil.	15,000 hectares planted annually for the last 5 years; 20-25% increase in farmer incomes.
Enhance soil water availability	Trees enhance soil carbon content which in turn increase the soil moisture holding capacity and prevents water run-off.	Water holding capacity increased by 10-15% for agro-forestry farms.
Increases carbon sequestration on land, and trees reduce greenhouse emissions on the farm	Increases carbon sequestration on land, and trees reduce greenhouse emissions on the farm.	60 million saplings planted leading to a reduction in greenhouse emissions.

Source: *IFC 2017*

Tools

Tool 1

Indicators to measure productivity, mitigation, adaptation and resilience

Table 22: Indicators to measure productivity, mitigation, adaptation and resilience
Measuring Productivity
Indicators used to measure productivity include:
1. Yield (e.g., product per unit of land, water, energy, nutrients, labour)
2. Income (e.g., gross margin, net present value)
3. Labour (e.g., person hours, labour allocations by gender)
Additional indicators to measure food security include:
4. Per capita food consumption in terms of calories, protein, dietary diversity
5. Food deficits, such as number of hungry months
6. Food prices
7. Percentage of income spent on food
8. Children's nutritional status (e.g., upper arm measurements to indicate wasting or stunting)
Measuring Mitigation
Indicators used to measure mitigation include:
9. Emissions of methane, nitrous oxide and carbon dioxide from all agricultural sources including energy, soils
10. Removals and accumulation of carbon in biomass and soils
11. Changes in land use, particularly conversion of high C land uses such as forests and peatland
12. Fuel wood consumption
13. Biofuel use
Measuring Adaptation and Resilience
Indicators used to measure adaptation and resilience include:
Social indicators
14. Access to capitals (financial, human, social/political, physical, natural)
15. Access to services (particularly climate information services)
16. Level of skills, knowledge and access to extension on climate change
17. Diversity in livelihoods and income sources
18 Market access (for food, agricultural inputs and agricultural product markets)
19. Gender equity (e.g., labour, income differences)
Biophysical indicators
20. Biodiversity (e.g., Shannon, N%)
21 Pests/pathogens (e.g., % loss, damage rates)
22. Erosion/soil loss (e.g., kg/ha)
23. Soil quality (e.g., changes in C, N, soil water balance, etc.)
Economic indicators
24. Income levels
25. Savings
26. Access to credit
27 Land rights/tenure
28. Access to insurance
29. Proportion of income from climate-prone sources
Institutional indicators
30. Enabling policy and regulation environment
31 Incentive systems
32. Subsidies (directed away from maladaptive practices towards resilience practices)
33. Safety net schemes
34 Early warning systems and disaster recovery strategies

Link source: https://csa.guide/csa/monitoring-evaluation-and-learning#tools-section

Exercises

Exercise 1

Divide the participants into four groups.

Ask them to list down different farming systems practiced in their region.

Let them identify whether each of these farming system/practice is favouring the three objectives of CSA: food security, adaptation and mitigation.

Ask them to suggest alternate farming practices to support CSA in their region.

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Unit VII: Approaches and Tools of EAS for CSA

Objectives

- Discuss the various extension approaches applied in disseminating CSA;
- Illustrate various tools and their application in CSA.

Introduction

Agriculture is the sector most vulnerable to the effects of climate change as it depends on many factors such as precipitation, temperature, soil health, etc., to function well. To overcome the challenges faced by climate change, we have proposed climate smart agriculture that can sustainably increase agricultural productivity and incomes, adapt and build resilience to climate change, and reduce or remove greenhouse gases emissions, wherever possible. Even though the importance of Climate Smart Agriculture (CSA) is accepted, the dissemination and uptake of climate smart technologies, tools and practices, is still largely a challenging process. The adaption of climate-related knowledge, technologies and practices to local conditions, promoting joint learning by farmers, researchers, and extension workers, and widely disseminating CSA practices, is critical. There is a need for site-specific assessments to identify suitable agricultural technologies and practices needed for CSA. EAS play an important role in helping farmers cope with the diverse impacts of climate change by using appropriate approaches to create awareness and making them aware of the different adaptation and mitigation strategies. To support a transition to climate smart agriculture, researchers have developed a wide range of tools and options for effective climate adaptation and mitigation in agriculture. These include climate information tools, an analogues tool, and options for smallholders to truly benefit from it. This unit presents some of the approaches/tools for screening, implementation and assessment of initiatives for climate-related risks, and could guide the user on their use.

Discussion

Extension Approaches used in CSA

The role of EAS has changed radically so as to meet the challenges faced by agriculture today. Addressing these global challenges requires generation, adaptation and use of new knowledge, which involves interaction and support from a wide range of organisations. One of the major challenges is climate change; and there are several ways that EAS can contribute to CSA. Different forms of climate information help farmers to make informed farming decisions. EAS play a major role in dealing with the climate change scenario by providing climate smart information to the farmers or by enhancing their capacity to increase their productivity, so that they can adapt to climate change (see Figure 22). Several extension methods/approaches have emerged to help farmers fight against climate change. Availability of adaptation or mitigation technologies is not sufficient for farmers unless they are aware of the consequences of climate change and are ready to fight them. Some of the different innovative extension approaches used worldwide to deal with the adverse impacts of climate change are given below (Rupan et al. 2018).

Climate awareness mass media campaigns: This helps to reach large numbers of farmers spread widely across geographical areas. Extension with mass media can also be run by non-extension players (e.g., radio or television) with technical inputs through SMS from extension workers, for awareness creation or simple information delivery.

	Type of information	Vehicles for delivering information	Farmer decisions affected
WEATHER Days to weeks	• Observed rainfall and temperature • Daily forecasts up to one week ahead of time • Alerts on pests and diseases • Early warning of extreme weather events	• Mobile phones • Radio • Television	• Timing of planting and harvest • Timing of fertilizer, pesticide, and irrigation application • Protecting lives and property from extreme events
CLIMATE VARIABILITY Months to Years	• Probabilities for seasonal rainfall and temperature conditions • Seasonal climate variables targeted to particular agricultural risks (dry spells, rainy season start date, etc) • Historical variability of climate variables	• Workshops with experts • Conversations with agricultural extension agents (farm educators)	• Selecting crops and varieties • Livestock stocking rates and feeding strategies • Intensity of input use (fertilizer, pesticides) • Labor or marketing contracts • Intensifying and diversifying crops • Diversifying sources of income
CLIMATE CHANGE Decades or longer	• Projections of future rainfall and temperature • Historical trends in rainfall and temperature • Historical changes in extreme events	• Workshops with researchers, agricultural extension agents, and meteorological services	• Major capital investments (buying or expanding landholding, irrigation systems, farm equipment etc) • Changing farming system or livelihood strategy • Deciding whether or not to farm

Figure 22: How farmers around the world are making decisions based on weather and climate information

Source: *Dinesh 2016*

This approach is best suited for awareness raising and has the potential to contribute to climate mitigation, adaptation, and to increase food security.

Climate training: Education/training of intermediaries/extension personnel is important to update their knowledge related to climate change, its impacts, and consequences or on different adaptation and mitigation strategies. As we know, climate smart agriculture is a new and emerging issue so extension service providers should be trained on this. There are various topics in which training can be given; one component is agro-meteorology, and extension service providers should be familiar with the local meteorological terms and should know how to read the scientific data or interpret it. Extension intermediaries should be closest to the farmers and operate exclusively at field level. They should learn to articulate the needs of farmer communities better and seek for (agro-meteorological) components that need attention. They should match this with what is or should become available as (agro-meteorological) services, be in strong contact with the product intermediaries. The extension intermediaries, for example in Climate Field Schools, train the farmers in Farmer Field Schools (Integrated Pest Management Farmer Field Schools as an existing but weakened example), and establish climate services for agriculture with the famers in their fields (Sala et al. 2016).

Plant/Agri Clinics: The plant clinic approach is similar to human health clinics; they are the frontline contact point of the national extension system and allow direct information exchange between extension workers and farmers on 'any problem and any crop'. Plant clinics are a channel for facilitating face-to-face exchange and two-way flow of knowledge and information between extension workers and farmers, and link to other components of a plant health system (Boa et al. 2015). The various crop problems brought to clinics can be related to either abiotic factors (e.g., nutrient deficiency, waterlogging, chemical misuse, etc.) or biotic factors (e.g., pathogens, insects, rats, etc.). Plant doctors should be knowledgeable about farmers and farming conditions, speak the local language, and know what inputs are available.

Climate Farmers Field Schools (FFS): The Farmer Field School (FFS) is a participatory, non-formal extension approach based on experiential learning that puts farmers and their demands at the centre (FAO 2002). It provides farmers with a low-risk setting to experiment with new agricultural management practices, discuss and learn from their observations, and it allows them to develop new practical knowledge and skills, and improve their individual and collective decision-making skills (Settle et al. 2014). FFSs have also integrated elements of climate change adaption, such as the FAO FFS programme on

Different Approaches used in Extension

- *Climate awareness programmes/ campaigns, exhibitions.*
- *Climate trainings.*
- *Climate workshops for plant health rallies.*
- *Climate Farmers Field Schools (FFS).*
- *Field visits to progressive farmers.*
- *Demonstration on different adaptation or mitigation practices.*
- *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.*
- *ICT-supported network.*
- *Participatory crop planning.*
- *Appointment of climate manager at the village level.*
- *Appointment of monsoon manager at the district level.*
- *Use of indigenous technical knowledge (ITKs).*
- *Establishment of plant clinics.*
- *Climate smart villages.*

Source: *Rupan et al. 2018*

Integrated Plant and Pest Management (IPPM) that promoted improved and adapted varieties, and agro-forestry practices (FAO 2015). Climate Field Schools in Indonesia raised awareness on climate change and promoted solutions to cope with changing rainfall patterns, such as recording and interpretation of on-farm rainfall measurements and in-field water harvesting (Winarto et al. 2008).

Plant Health Rally Approach: It is an extension method for quickly raising awareness about major agricultural risks or threats on important crops, to promote the use of improved agricultural practices, and to collect feedback from farmers on major issues which affect production. The plant health rally approach, first described by Bentley et al. (2003), is complementary to the plant clinic approach as it differs in terms of reach, impact and complexity of the messages that it can transmit. Plant health rallies are run by local extension workers. They are usually held in public spaces and are open to everybody. A plant health rally may be spontaneous, attracting people with a banner and other announcements, or may target farmers who have been specifically mobilized for the event. The approach can also contribute to climate change mitigation, for example, plant health rallies would be a perfect fit as a vehicle for putting mitigation research (such as urea deep placement technology in rice production) into use and thus reducing greenhouse gas emissions in paddy rice cultivation.

Contingency Crop Planning: It is a document that includes the recommendations across the key aspects of crop management and cultural practices. This form of calendar is very useful in terms of crop planting, irrigation scheduling, and plant protection measures for farmers. It is done on the basis of local weather conditions for the local crops grown in that particular area. It is participatory in nature because the local knowledge of farmers about the crops or various agricultural practices and the scientific knowledge of scientists both play an important role in crop planning. It is prepared with the help of the agro-meteorological department.

ICT supported network: Information and Communication Technologies (ICTs) played an important role as a medium of information and communication in climate change awareness, adaptation and mitigation strategies. However the availability and adoption of ICTs is varied between areas, developed and developing countries, urban and rural areas, and within rural areas themselves. Mobile phones, videos, radios, etc., were used to address the issue of climate change by creating awareness among the farmers about the availability of different adaptation and mitigation strategies.

Farmer-to-Farmer Extension (F2FE): F2FE offers great promise for effectively scaling up CSA. The approach empowers farmers to be change agents and helps to increase adoption because farmers are more willing to learn from their colleagues than from extension staff (Franzel et al. 2015). F2FE programmes contribute to all CSA, that is, they help improve productivity, build resilience, and reduce greenhouse gas emissions.

Climate-Smart Villages (CSVs): CSVs are the developed villages or models of local actions that ensure food security, promote adaptation and build resilience to climatic stresses. CSVs have four components: climate information services; local knowledge and institutions; village development plans; and climate smart technology. The location of a CSV is selected based on its climate risk profile and the willingness of farmers and local governments to participate in the project. There is no fixed package of interventions or a one-size-fits-all approach. The emphasis is on tailoring a portfolio of interventions that complement one another and also suit the local conditions.

Box 7. Farmer friend – Facilitating climate led extension

The Adarsha Rythu (Model Farmer) scheme was introduced by the erstwhile Andhra Pradesh government in 2007, which aims to reduce the farmers' dependence on extension functionaries for crop production advisories, and solve the farm problems in a timely manner. These model farmers facilitate the reach of the public extension systems effectively. The significant roles of Adarsha Rythu have become an integral part of climate-led extension. Knowing the importance of Adarsha Rythu, the NGO Adarsha Rural Development and Training Society has introduced the Adarsha Rythu-led extension to tackle climate change and to adapt agriculture to the vagaries of climate. The Adarsha NGO has associated with the Government of Andhra Pradesh for funds and manpower to create climate resilient agriculture. As of today, the Adarsha NGO makes use of the 25 Adarsha Rythus for the dissemination of climate information and climate resilient cropping pattern, technologies and good agriculture practices relating to minor millet production and value chain management. At present, these 25 Adarsha Rythus that cover about 30 Panchayats in the Hindupur and Kadiri tehsils (Anantapur district) and serve as the point of contacts for the farmers in these two blocks.

Source: *Vincent 2019*

Tools and their Application

Climate risk screening and assessment tools

1. Adaptation Wizard

The Wizard helps to identify organisation's vulnerability to current climate and future climate change, identify options to address an organisation's key climate risks, and helps to develop and implement a climate change adaptation strategy. It was developed by UK Climate Impacts Programme and can be implemented at an organizational level. It follows a five-step process to assess vulnerability to climate changes and identifies options to address key climate risks. (see Figure 23)

Approach: User-friendly info- and structuring computer-based tool following a risk-based approach.

Target audience: Planners and managers

Link

www.ukcip.org.uk/index.php?option=com_content&task=view&id=147&Itemid=297

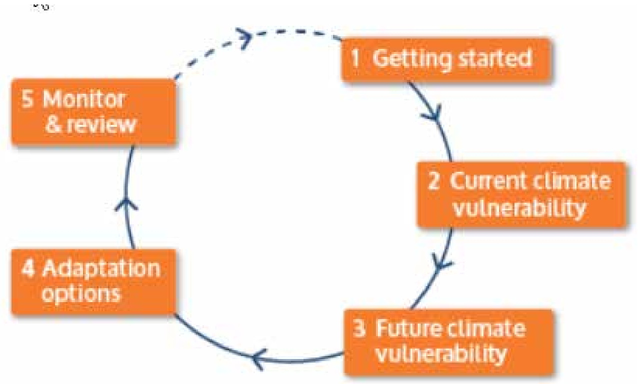

Figure 23: Diagram of Adaptation Wizard

2. Climate change adaptation through integrated risk assessment (CCAIRR)

The approach is comprised of five main components: Capacity assessment and strengthening, review of knowledge data and tools, rapid risk assessment, mainstreaming, and monitoring and evaluation. It is an integrated package that can be customized to meet the specific needs and capacity of a given end user. CCAIRR illustrates the adaptation mechanism as the means to manage risks associated with the full spectrum of hazards, from extreme events to the consequences of long-term climate change, and should be an integral part of community and national development planning. It was developed by the Asian Development Bank and can be implemented at the programme level. (see Fig 24).

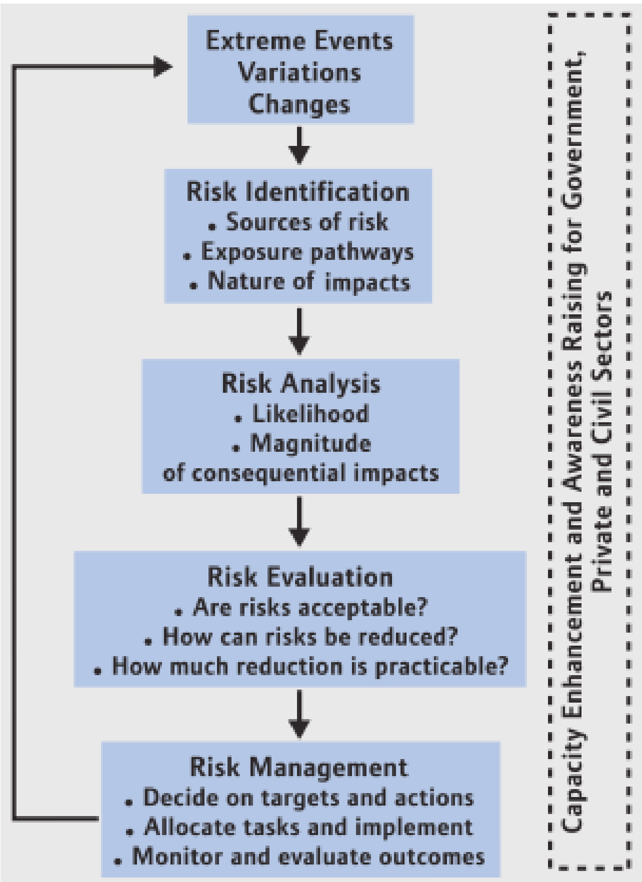

Figure 24: The integrated risk reduction methodology that underpins CCAIRR – addressing both response to disasters and adaptation to climate variability and change

Approach: Risk- and case study-based approach

Target audience: Development project planners and managers

Link http://www.adb.org/Documents/Reports/Climate-Proofing/chap8.pdf

3. Climate change and Environmental Degradation Risk and Adaptation assessment (CEDRA)

This tool assists in prioritising which environmental hazards may pose a risk to existing project locations, and supports the decisions to adapt projects or start new ones. It is developed by Tearfund and implemented at the project level.(see figure 25).

Approach: Participatory process for multi-stakeholder consultations.

Participatory decision making: Many of the CEDRA exercises would best be carried out through focus group meetings which include a range of stakeholders. If possible, these should be conducted as part of community meetings that are an ongoing part of project planning or usual pre-project needs assessments. This would enable stakeholders to play a strategic role in selecting the most sustainable adaptations, and should result in a strong sense of ownership by them. It should also encourage further valuable sharing of knowledge.

Collaboration and knowledge sharing: CEDRA is best used by a group of development agencies working together. This can have many advantages, including sharing of workload, skills and resources, and creating a joint advocacy platform to influence policy change or to get other agencies on board with environmental issues.

Target audience: Development project planners and managers

Link

http://tilz.tearfund.org/Topics/Environmental+Sustainability/CEDRA.htm

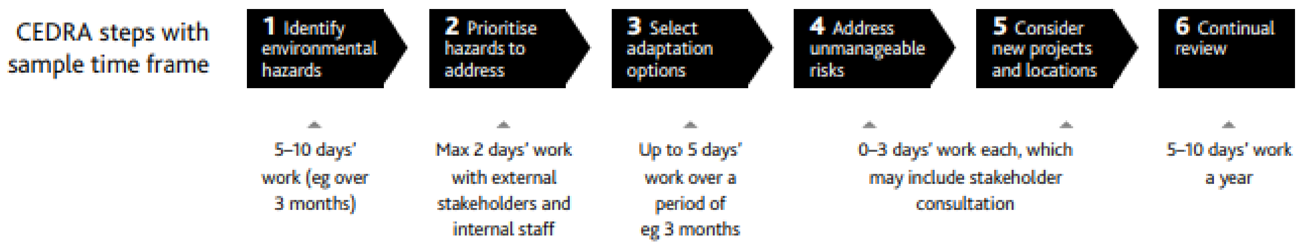

Figure 25: CEDRA steps with sample time frame

4. The Community-based Risk Screening Tool - Adaptation and Livelihoods (CRiSTAL)

It is a user-friendly conceptual framework aimed at raising awareness on climate change adaptation. It facilitates the identification and organization of an adaptation strategy. It was developed in response to the outcomes of the first phase of the Livelihoods and Climate Change initiative, which demonstrated how ecosystem management and restoration and/ or sustainable livelihood projects contribute to risk reduction and climate change adaptation. By securing the local natural resource base and diversifying livelihood activities, these projects can reduce exposure to climate hazards and increase community resilience to a range of threats, including climate variability and change. It was developed by IUCN, SEI- US, IISD, Intercooperation and implemented at project level (see figure 26).

Approach: Participatory and vulnerability-based approach, step-by-step, computer-based method

Target audience: Development project planners and managers

Link http://www.cristaltool.org/

Climate impacts assessment tools

5. MOSAICC (Modelling System for Agricultural Impacts of Climate Change)

MOSAICC has been developed by the Food and Agriculture Organization (FAO) of the UN in the framework of the EC/FAO Programme on linking information and decision making to improve food security. MOSAICC is an integrated package of models for assessing the impact of climate change on agriculture, including variations in crop yields and their effect on national economies.

Purpose: MOSAICC is designed to be deployed at the national level in different institutions with relevant data and competencies (e.g., ministries of agriculture or environment, weather services, research centres, universities, etc.). A multidisciplinary working group is set up to manage the system and lead impact assessment projects. Training on system utilization and maintenance can be provided.

Use and users: The main components of the system are: one statistical downscaling portal to downscale Global Circulation Models (GCM) data to weather stations networks; one hydrological model for estimating water resources for irrigation in major basins; two water balance-based crop models to simulate crop yields under climate change scenarios; and finally one Computable General Equilibrium model (CGE) to assess the effect of changing yields on national economies. The system also includes documentation on methods and tools, as well as user manuals and sample data. The system is typically deployed in national institutions (ministries, research institutes, universities, etc.), delivered with training sessions, under the framework of an inter-institutional agreement, and supported by trust funds.

Possible applications include: assessing climate change at the local level; monitoring the impact of climate change on water resources, crops and food security; vulnerability analysis; simulations of policy response in agriculture; etc. The system and interfaces can be readily adapted to meet the needs of end-users.

Links

The FAO modelling system to assess climate change impacts on agriculture at national level:

www.fao.org/climatechange/mosaicc/en/

The Modelling System for Agricultural Impacts of Climate Change (MOSAICC):

http://www.fao.org/climatechange/34871-0c61824b36f6cd0dfe1daea75cf06e453.pdf

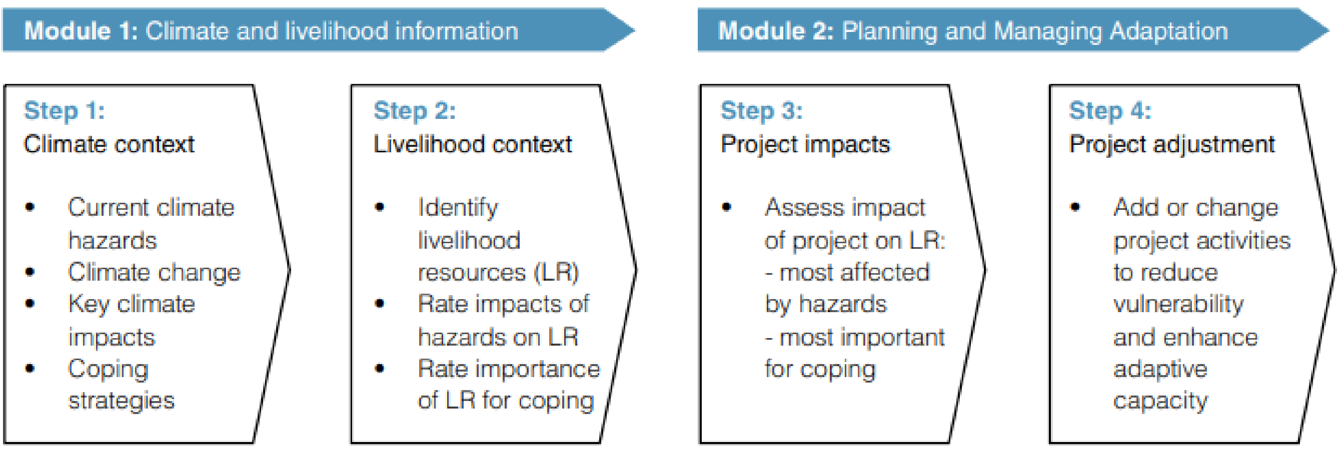

Figure 26: Application of CRiSTAL tools

6. Climate Wizard: Online Climate Change Analysis Tool

The tool was developed in 2009 by CIAT, CCAFS and the World Bank through collaboration with the Nature Conservancy, the University of Washington, and the University of Southern Mississippi.

Purpose: The Climate Wizard enables technical and non-technical audiences alike to access leading climate change information and visualize the impacts anywhere on earth.

Use and users: With Climate Wizard users can view historic temperature and rainfall maps, view state-of-the-art future predictions of temperature and rainfall, and view and download climate change maps in a few easy steps. The website is designed to be integrated within the government or other institutional websites to provide a seamless look and user experience. The Climate Wizard programme can provide climate analysis services tailored to the needs of specific decision makers and institutions in Africa. Drawing on a wide range of data, this programme develops products to support climate risk analysis and resilience/adaptation planning. Moreover, the website is designed to be integrated within the government or other institutional websites to provide a seamless look and user experience.

The tool provides metrics on interpreting risks within a specific sector or service, such as:

- Water supply focused on total precipitation and two measures of dryness and drought conditions;
- Flood risk driven by rainfall average, measures of wet day rainfall, and short term maximum rainfall intensities;
- Human health focuses on temperature stress (hot and cold) to people: hottest and coldest single day temperature;
- Energy demand incorporates heating and cooling demand using heating and cooling degree days;
- Agro-ecosystem impacts to climate change incorporates many aspects, including total precipitation, dry conditions, extreme hot and cold temperatures, and growing degree days.

Links

Visit the Climate Wizard at http://climatewizard.ciat.cgiar.org and http://ClimateWizard.org

7. CCAFS MarkSimGCM Tool

The MarkSim tool was developed by Waen Associates and is supported, among others, by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Purpose: This tool is a stochastic (random) weather-generating platform that aims to help online users generate simulated daily weather data across the globe. It can deliver information about rainfall, maximum and minimum temperatures and solar radiation, and has been specifically designed for tropical countries.

Use and users: The tool can be used to generate daily data for multiple years that are characteristic of future climate for any point in the world. To do so the users can chose which greenhouse gas emission pathways to use from the IPCC's Fifth Assessment Report. The ambition is to support agriculture and climate researchers and help feed valuable information to agricultural impact models. For current weather conditions, MarkSimGCM uses the WorldClim dataset. WorldClim is an interpolated surface of weather station data from around the world where you can find climate data for past, current and future conditions. It is free of cost.

Links

MarkSim GSSAT weather file generator: http://gisweb.ciat.cgiar.org/MarkSimGCM/
Pattern Scaling with MarkSim Weather Generator: http://www.ccafs-climate.org/pattern_scaling/#standard_version
MarkSim manual: http://ccafs-climate.org/downloads/docs/MarkSim-manual.pdf

Vulnerability assessment tools

8. Framework for Climate Change Vulnerability Assessment

The Framework for Climate Change Vulnerability Assessment was prepared as part of the Indo-German development cooperation project 'Climate Change Adaptation in Rural Areas of India' (CCA RAI).

Purpose: The aim is to provide a structured approach and a sourcebook for assessing vulnerability to climate change. Furthermore, it provides a selection of methods and tools to assess the different components that contribute to a system's vulnerability to climate change. Key questions addressed are:

- How to plan for a vulnerability assessment?
- Which tools or methods to select to carry out a vulnerability assessment?
- How to carry out a vulnerability assessment?

Use and users: The framework has been developed for decision-makers and adaptation implementers such as (local) government officials, development experts and civil society representatives. The information on this starts with the theoretical background behind the concept of vulnerability. Next, two broad approaches for assessing vulnerability are introduced: vulnerability assessments can be carried out either at a local level using participatory methods and tools as well local climate data (bottom-up assessments); or at state, national or global level using large-scale simulation models and statistical methods (top-down assessments). The introduction to the concept of vulnerability is followed by the main framework consisting of four different stages for assessing a system's vulnerability to climate change. Each stage in the vulnerability assessment consists of steps that specify which kinds of analyses should be carried out in that stage. Every step contains a set of guiding questions and a list of suggested methods and tools that can be used to answer these questions.

Each stage of the framework is followed by two practical examples of vulnerability assessments carried out in India: a bottom-up vulnerability assessment carried out at the outset of a GIZ-supported climate change adaptation project, and a top-down vulnerability assessment carried out for the Indian State of Madhya Pradesh as a whole. It presents an extensive, yet not exhaustive, selection of methods and tools that can be used to assess the components of vulnerability to climate change at different levels (GIZ 2014).

Link

GIZ. 2014. Framework for Climate Change Vulnerability Assessment:

https://www.weadapt.org/sites/weadapt.org/files/legacy-new/knowledge-base/files/5476022698f9agiz2014-1733en-framework-climate-change.pdf

9. The Sustainable Livelihood Framework for Assessing Community Resilience to Climate Change

The framework was developed by DFID's Sustainable Rural Livelihoods Advisory Committee, building on earlier work by the Institute of Development Studies (among others).

Purpose: The framework was developed to help understand and analyse the livelihoods of the poor. A livelihood may be understood as the capabilities, assets (including both material and social resources), and activities required for a means of living. A livelihood is sustainable when it can cope with, and recover from, stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base. Hence, a community's vulnerability and coping capacity, or resilience, to climate change can be assessed using the sustainable livelihood framework.

Use and users: The sustainable livelihood framework shows the relationships between household assets, their vulnerability and the institutional context, which determine household livelihood strategies and their outcomes. The asset pentagon lies at the core of the sustainable livelihood framework. It visually presents information about the type and level of assets the community possesses. The pentagon consists of five different types of assets or capitals: human, social, natural, physical, and financial. In general, it can be said that households with fewer assets are more vulnerable to external shocks. However, it is not only the limited amount of assets that matter in measuring people's coping capacity. Other factors are also important, including the quality of the assets, whether and how people have access and rights to the resources, whether and how they can use them, and whether and how the resources are or can be shared. Moreover, the institutional context, which consists of policies, institutions and processes, can also influence people's access to assets and the range of livelihood strategies available to them. Assessing changes in these assets can help to determine a household's resilience to external shocks.

A project in Sudan 'An Assessment of Impacts and Adaptations of Climate Change', for example, used the sustainable livelihood framework to measure the impact of project interventions on a community's resilience. For each type of capital, a set of criteria and indicators were developed (Elasha et al. 2005).

Link

Elasha BO, Elhassan NG, Ahmed H and Zakieldin S. 2005. Sustainable livelihood approach for assessing community resilience to climate change: Case studies from Sudan. Assessments of Impacts and Adaptations of Climate Change (AIACC), Working Paper No 17, AIACC.

http://www.start.org/Projects/AIACC_Project/working_papers/Working%20Papers/AIACC_WP_No017.pdf

Prioritization tools

10. Climate-Smart Agriculture Rapid Appraisal

It was carried out by the International Center for Tropical Agriculture (CIAT) in collaboration with Sokoine University of Agriculture (SUA) for the Southern Agricultural Growth Corridor of Tanzania (SAGCOT), in September 2014.

Purpose: The CSA-RA provides an assessment of key barriers and opportunities to CSA adoption across landscapes by collecting gender-disaggregated data, perceptions of climate variability, resource and labour allocation, as well as economic assessments at the household level.

The CSA-RA is intended to:

Obtain a preliminary understanding of farming systems, household characteristics, infrastructure, land tenure, household expenditure, asset ownership, profitability of the farming enterprises, and other important agriculture-related features;

- Identify farmers' perceptions of weather patterns (e.g., climate variability) and its perceived impact on agricultural production;
- Obtain a preliminary understanding of major challenges and constraints faced by farmers (i.e., climate variability, land health, specific cropping and/or livestock issues, markets, etc.);
- Identify existing and potential CSA practices, agronomic and land management practices, as well as assess demonstration plots of these practices;
- Identify opportunities for mainstreaming CSA and potential social, economic and/or institutional barriers to adoption;
- Identify gender dynamics related to objectives.

Use and users: This approach combines participatory workshops, expert interviews, household/farmer interviews, and farm transect walks to gather and capture the realities and challenges facing diverse farming communities.

Links

Climate Smart Agriculture Rapid Appraisal (CSA-RA) Prioritization Tool: https://ccafs.cgiar.org/climate-smart-agriculture-rapid-appraisal-csa-ra-prioritization-tool

11. Climate-Smart Agriculture Prioritization Toolkit

Purpose: To be able to assist farmers and policymakers in prioritizing strategic CSA interventions, the CCAFS team in South Asia, together with local partners, is developing a Climate-Smart Agriculture Prioritisation Toolkit (CSAP). The toolkit allows the user to identify robust decisions, that is, the best possible decisions within a set of uncertain circumstances. It is then feasible to carry out a trade-off analysis of alternative climate smart agriculture development pathways, and thus support decisions on which crops to cultivate, which climate smart agricultural technologies and practices to invest in, where to target that investment, and when to make these investments.

Use and users: The CSAP toolkit is built on a spatially-explicit land-use planning framework of agricultural production accounting for (i) spatial crop-yields, inputs/outputs, and production costs; (ii) land, water and labour availability; and (iii) greenhouse gas emissions from agriculture. The toolkit is designed as a linear mathematical programming model, and requires a detailed location-specific database on soil, crop varieties, cropping area, agronomic practices, irrigation and historical weather information along with socio-economic data. This database is set within a spatially-explicit modelling framework that is capable of handling a wide range of constraints and scenarios. The land-use model calculates minimum-cost pathways to meet future demand targets under a range of agricultural growth scenarios. Future crop yields, water-use and emissions are forecast under different climate-scenarios using crop-modelling techniques and empirical evidence.

CSAP is being tested in the State of Bihar, India, where CCAFS is developing a range of baseline growth scenarios, and assessing their vulnerability to climate change impacts for the near-term (2020s), mid-term (2050s) and long-term (2080s) under CMIP5-based emission scenarios. Here, the project has been able to demonstrate the potential of the model to identify priorities for investment in: (i) Crops best suited to delivering target growth under impacts of climate change on yields; (ii) Technologies to deliver targeted increases in productivity, based on potential yield increases and the efficient use of resources; and (iii) Locations for priority investment given an existing surplus of productive capacity. Apart from this, the investment required to climate-proof agricultural development is explicitly identified – providing valuable bottom-up evidence to support top-down estimates of the costs of climate change adaptation.

Link

A toolkit to prioritise interventions in climate-smart agriculture: https://cgspace.cgiar.org/rest/bitstreams/38402/retrieve

12. ClimMob

ClimMob is a software for crowdsourcing climate smart-agriculture. It is created by Jacob van Etten and developed by Bioversity International, and it turns the research paradigm on its head. Instead of a few researchers designing complicated trials to compare several technologies in search of the best solutions, it enables many farmers to carry out reasonably simple experiments that taken together can offer even more information.

Link

You can access it for free at https://climmob.net/climmob3/. Version 3 uses Open Data Kit (ODK) for collecting information on mobile devices. You can also grab it from the Google Application Store.

13. targetCSA

Planning for agricultural adaptation and mitigation has to depend on informed decision-making processes. Stakeholder involvement, consensus building and the integration of comprehensive and reliable information represent crucial, yet challenging, pillars for successful outcomes. The spatially-explicit multi-criteria decision support framework targetCSA aims to aid the targeting of climate smart agriculture (CSA) at the national level. This framework integrates quantitative, spatially-explicit information such as vulnerability indicators (e.g., soil organic matter, literacy rate and market access) and proxies for CSA practices (e.g., soil fertility improvement, water harvesting and agroforestry) as well as qualitative opinions on these targeting criteria from a broad range of stakeholders. The analytic hierarchy process and a goal optimization approach are utilized to quantify collective, consensus-oriented stakeholder preferences on vulnerability indicators and CSA practices. Spatially-explicit vulnerability and CSA data are aggregated and coupled with stakeholder preferences deriving vulnerability and CSA suitability indices. Based on these indices, relevant regions with the potential to implement CSA practices are identified. targetCSA contributes valuable insights to the development of policy and planning tools to consensually target and implement CSA.

Link

Brandt P, Kvakić M, Butterbach-Bahl K and Rufino MC. 2017. How to target climate-smart agriculture? Concept and application of the consensus-driven decision support framework "targetCSA". Agricultural Systems 151:234–245.

https://reader.elsevier.com/reader/sd/pii/ken=19C7736269A4CF4766AE7B75951C67BDF4A268E8FFC9AEA9D02725CACAE9EEFF52314B088CECAE12A62926332EC1A70B

Programme support and implementation tools

14. Developing early warning systems: A checklist by International Strategy for Disaster Reduction

Early warning systems and other climate information services help farmers and government agencies plan farming activities and programming. A variety of organizations have developed guidelines for setting up early warning systems. Here we highlight a checklist that has been developed by International Strategy for Disaster Reduction. This checklist is broken down into four key elements: risk knowledge, monitoring and warning service, dissemination and communicating, and response capability. Programme developers can go through the four elements, each consisting of approximately 20 key components. By considering the statements in relation to what is available in the local context, programme developers can identify what infrastructure is already in place, what is missing, and what needs to be strengthened. The checklist therefore helps to set the implementation priorities for the programme. The checklist here was developed as an outcome of the Third International conference on Early Warning, held in Bonn, Germany, in 2006.

Link

The checklist can be downloaded at http://www.unisdr.org/files/608_10340.pdf

GHG measurement tools

15. Mitigation Optimization Tool

Researchers at the University of Aberdeen, in partnership with CCAFS, the International Centre for Tropical Agriculture (CIAT), and the University of Vermont's Gund Institute for Ecological Economics, are developing a Mitigation Options Tool for calculating greenhouse gas emissions from different agricultural practices.

Purpose: The CCAFS Mitigation Options Tool (CCAFS-MOT) estimates greenhouse gas emissions from multiple crop and livestock management practices in different geographical regions, providing policy-makers across the globe access to reliable information needed to make science-informed decisions about emission reductions from agriculture.

Use and users: Several GHG calculators (now available) calculate emissions from either single crops or whole farms. Unlike these agricultural calculators, CCAFS-MOT:

- Ranks the most effective mitigation options for 34 different crops according to their mitigation potential, and in relation to current management practices as well as spatially-linked climate and soil characteristics;
- Has low-input data requirements – approximately 10 minutes are needed;
- Runs in Excel;
- Will be freely downloadable from the CCAFS website.

CCAFS-MOT joins several empirical models to estimate GHG emissions from different land uses and

considers mitigation practices that are compatible with food production. Several studies that informed mitigation potentials are used in this tool.

Link

CCAFS Mitigation Option Tool for agriculture: https://ccafs.cgiar.org/mitigation-options-tool-agriculture

16. The EX-Ante Carbon-balance Tool (EX-ACT)

It is an appraisal system developed by FAO.

Purpose: It provides ex-ante estimates of the impact of agriculture and forestry development projects, programmes and policies on carbon-balance. Carbon-balance is defined as the net balance from all greenhouse gases (GHGs) expressed in CO2 equivalents that were emitted or sequestered during project implementation as compared to a business-as-usual scenario.

Use and users: EX-ACT is a land-based accounting system, estimating C stock changes (i.e., emissions or sinks of CO2) as well as GHG emissions per unit of land, expressed in equivalent tons of CO2 per hectare and year. The tool helps project designers to estimate and prioritize project activities with high benefits in economic and climate change mitigation terms. The amount of GHG mitigation may also be used as part of economic analyses, as well as while applying for additional project funds.

EX-ACT can be applied to a wide range of development projects including, among others, projects on climate change mitigation, sustainable land management, watershed development, production intensification, food security, livestock, forest management or land use change. Moreover, it is cost-effective, requires a comparatively small amount of data, and provides for features (tables, maps) which can help find the required information more easily. While EX-ACT is mostly used at the project level, it may easily be up-scaled to the programme/sector level, and can also be used for policy analysis.

Link

FAO EX-ACT Tool: http://www.fao.org/tc/exact/carbon-balance-tool-ex-act/en/

17. Cool Farm Tool

This is a simple but powerful online greenhouse gas calculator that helps farmers to work out the impact of their various operations on the environment, as well as on their productivity.

The Tool has been designed as a farmer-focused, action orientated and interactive greenhouse gas calculator for agriculture that

- Works across the globe and across farming systems and delivers comparable results (recognizing that empirical data on emission is heavily skewed to the global North);
- Is as management sensitive as possible, i.e., mirrors the choices that farm managers can actually make, which affect GHGs;
- Limits data requirements to information that farm managers would typically have readily available;
- Offers interactivity and results in a way that draws farmers into exploring improvement options and what-if scenarios.

The GHG results are reported in totals per crop unit or per hectare/acre and broken down by emissions category. The tool is free to use for individual farmers for internal management. Commercial use by supply chain businesses requires a use/membership fee. The tool and fee details can be accessed at www.coolfarmtool.org

Monitoring, evaluation and learning tools

18. CSA Programming and Indicator Tool

CGIAR CCAFS in collaboration with USAID Feed the Future, designed the CSA Programming and Indicator Tool to address both the need of good instruments for programming, and better metrics for tracking outcomes and impact, and to allow multiple development agencies and agriculture-focused programmes to share a common framework on how they are currently addressing CSA, and how they can make their future programming process more climate smart.

Purpose: The CSA Planning and Indicator Tool guides the user through a thoughtful and transparent process to:

- Examine through a three-dimensional lens (of productivity/income, adaptation, and mitigation) to what extent its current intervention addresses each of the CSA pillars, or what might be the potential climate smartness of a planned intervention;
- Compare the scope and CSA intentionality among different project designs; and
- Support the identification and selection of an appropriate set of indicators to measure and track CSA outcomes.

Use and users: By going through this CSA programming process, donors and implementers can:

- Provide visibility to CSA impact areas not originally targeted or focused by the intervention;
- Strengthen the planning phase of interventions to ensure that all potential CSA-related outcomes (beyond the productivity/income pillar) are properly included in the monitoring and evaluation (M&E) design; and
- Increase awareness on how to 'make' their future interventions' planning process climate smart.

Supported by a database of over 378 indicators with CSA-related indicators gathered from several international development agencies/institutions (FAO, DFID, GIZ, IFAD-ASAP, World Bank, USAID and CCAFS), this tool can facilitate the delivery of not only productivity outcomes, but can also positively track adaptation and mitigation impacts.

Link

CGIAR CCAFS. CSA Programming and Indicator Tool

https://ccafs.cgiar.org/csa-programming-and-indicator-tool#.Xkp3CWgzbIW

Conclusion

Through this unit extension personnel can gain knowledge on the different methods/approaches in extension used to deal with climate change. It also helps in understanding the nature and use of the most important toolkits developed until now for climate change/risk screening, learning and assessment. Better understanding of these approaches/tools can help in managing the risks in a future climate.

Cases

Case 12: Innovative Extension Approaches for Climate-Smart Agriculture: NICRA, CCKN-IA, and CCA projects

Out of three projects, two projects NICRA and CCKN-IA were under government organisations (ICAR), and one CCA was under an NGO – so they all used different methods for climate knowledge transfer based on the location/area where they worked. Most of the adaptation activities in the study area (Maharashtra) were done by Watershed Organisation Trust (WOTR) under the CCA project, and it worked efficiently for the farmers. NICRA aimed at enhancing resilience to climate change through technological interventions while CCKN's main focus was on the use of Information and Communications Technology-based knowledge 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. Effective adaptation of the CSA advisories generated by different projects can only be achieved if farmers have sufficient awareness and knowledge on climate change issues, like what is climate change, how it is affecting agriculture, what are the consequences and impact, and so on. So different projects used different methods according to their clients, location and objectives. Some of them are discussed below.

Extension Methods for Transfer of Climate Knowledge

SMS or Short Messaging Services: Short text messages of 160-164 characters in the local language (Marathi) were sent to registered mobile numbers of farmers. Maximum two SMS per week, based on weather advisories and contingency plans, were sent to the farmers.

Climate Wallpapers: One-page advisories in the form of tables or posters relating to weather predictions for agricultural operations that needed to be performed, were pasted on common display boards of villages to provide advisory services to farmers. In CCA project, these advisories were named Krishi Salah.

Climate Voice Messages: SMS were converted into voice messages in the areas with low literacy rate and disseminated to farmers.

Folk media: Some *nukkad natak* (street plays) on the effects of climate change on agriculture were prepared under the CCA project, so that farmers could know more about the changing climatic conditions.

Use of Public Address System (PAS): Farmers were informed about critical climatic conditions or agro-advisory services with the help of this in the villages where SMS was not delivered due to network or electricity problems. . For example, if rainfall was expected the next day, farmers would be immediately informed so that they could plan their farming activities accordingly. In Pathar, one cluster in Sangamner block, one permanent PAS is located in a temple in the village for public announcements on climatic conditions.

Climate Group Meetings: Farmers were organised in a group because it is easy to connect them or to disseminate climate-related information to them in a group. Various committees were formed in the village to look after different components – like under the CCA project village development committees (VDC) were formed. There were 10-15 members in a committee and there was also 40-50% reservation for women in all the committees.

Exposure Visits were conducted for farmers in the fields of progressive farmers, such as those who grow pomegranate, use organic slurry for their crop, use drip or sprinkle irrigation etc., so that they could also be motivated to adapt these mitigation measures.

Climate Workshops: Various workshops on different topics, such as preparation of water ponds, pomegranate cultivation, use of organic fertiliser, custom hiring centres, etc., were conducted to make farmers aware of such.

Extension methods for learning

Climate Field Group Visits: It was observed that for the creation of location-specific agricultural information, a content team must visit the project sites twice in a season: first at the start of the season, followed by one in the middle of the season. The objective of the visit is to collect information about actual field conditions, agro-meteorological issues, ongoing government schemes, etc.

Farmer Interest Groups (FIGs): Promotion of FIGs was done to organise them in a group on the basis of their commodity or enterprise because it is easy for dissemination of information. There are different groups in the villages (both men and women), such as the group of poultry-rearing farmers, goat-rearing farmers, women SHGs, etc. FIGs make it easy to provide them with customised information. So it saves the time of both farmers as well as service providers. It was found that all activities promoted through FIGs were more effective.

Climate Trainings: It was given to agricultural extension workers in order to decide how to use the NICE platform to give advisory services to the farmers, and how to collect feedback from the farmers in CCKN project. Rain gauges were installed in farmers' fields as per the norm of Indian Meteorological Department (IMD), and then KVK experts get in direct contact with these farmers to collect rainfall data. IMD provided technical material and field training to KVK experts and farmers on importance of rain gauges and how to install rain gauges at field level. Training was also given to the youths or farmers of the village on how to read data from automated weather station, or how to read temperature, or how to interpret that information.

Informative Crop Calendar: It is a type of calendar which provides a package with information on all the agricultural practices of crops. It includes planning, irrigation scheduling, and plant protection measures based on weather-based management. It is based on the area or specific cropping pattern of that particular area. Under the CCA project, a crop calendar was prepared with the help of CRIDA for the key crops grown in the Akola or Sangamner block of Ahmednagar. It includes weather-specific crop advisory services for specific crops such as paddy, finger millet, groundnut, etc.

Livestock Calendar: Livestock is an important component of livelihood that not only supports the income of the farmers but the output also helps them in organic cultivation practices. Under CCKN, a similar calendar on livestock with monthly advisories, government schemes, vaccination schedules, best practices, etc., were published and distributed to farmers, higher authorities and extension officers.

Block Contingency Planning: Contingency plans are technical documents containing integrated information on agriculture and allied sectors, i.e., horticulture, livestock, poultry, fisheries and technological solutions for all the major weather-related aberrations including extreme events such as droughts, floods, heat wave, cold wave, untimely and high-intensity rainfall, frost, hailstorms, pest and disease outbreaks. CRIDA prepared these documents which are meant to be utilised by district authorities. However, a constantly-felt need for localising these plans further to the block level to effectively tackle local impacts was the key motivation for this entire innovative approach.

Information & Communication Tools: NICE (Network for Information on Climate (Ex)Change) platform, used under the CCKN IA project, is an IT-based system that facilitates gathering and disseminating up-to-date and relevant information to the farmers for sustainable agriculture. Mobile phones were also used to send weather-based crop advisories to farmers.

Extension methods for capacity development

Climate Trainings: Training was given to farmers on different adaptive or mitigation practices, including mulching, SRI cultivation, use of organic fertilisers, use of jaivaamrit and organic slurry, construction of polyhouse, drip irrigation, growing of less water-intensive crops in the area, dairy, poultry and goat rearing, silage making, etc.

Climate Workshops: Workshops on different topics such as preparation of water ponds, pomegranate cultivation, use of organic fertiliser, custom hiring centre, crop insurance, etc., was conducted to make farmers aware.

Field Demonstration: Field demonstration was undertaken for management of bacterial disease in pomegranate. Farmers were asked to adopt proper management practices, such as application of organic manures, neem cake, vermicompost and bio-fertilisers. Similarly, awareness has also been created regarding importance of mulching to reduce soil temperature. Demonstrations on rearing of Srinidhi or Vanaraja breeds of poultry for backyard poultry for egg and meat purpose, and drumstick plantation were given.

Climate-Smart Farmers Field Schools (CFFS): Climate-resiliency Field Schools have promoted the practice of organic farming, various systems for rice intensification, and the establishment of community seed banks and other practices, such as soil conservation, reforestation, and agro-forestry for increasing crop production. Climate-resiliency Field Schools serve as a multi-level institutional platform where farmers can access climate information, which they can use to improve farm planning (i.e., choices of crops, timing of farm preparation, and harvest).

Weather-based Insurance: Well-designed and targeted agricultural insurance can enable farmers to re-invest in inputs and technologies despite bad years. Hundred percent of farmers used crop insurance scheme to protect their crops from any hazards in the study area. It was stated in the notes of CGIAR that in India, 30 million farmers are covered under crop insurance schemes to protect their crops from climate change.

Community Based Disaster Management (CBDM) approach: WOTR has developed a community based disaster management (CBDM) approach to build capacity of communities to reduce impacts and to cope with disasters more effectively. Community participation and ownership in disaster risk reduction (DRR) is the key to minimising losses. Under this, disaster risk reduction clock of a village was prepared under which the points or places of the villages which are sensitive to climatic disaster were identified and then training was conducted for the villagers to make them aware of it. Mock safety drills were also conducted for school children or villagers.

Village Level Custom Hiring Centre (CHCs): Mechanisation brings in timeliness and precision to agricultural operations, greater field coverage over a short period, cost-effectiveness, efficiency in use of resources and applied inputs. Custom Hiring Centres (CHCs) for farm implements were established in the villages which could successfully empower farmers to tide over the shortage of labour and improve efficiency of agricultural operations. The most popular implements kept at the centre are: rotavator, zero till drill, drum seeder, multi-crop planter, power weeder and chaff cutter. A committee of farmers nominated by the Gram Sabha manages the custom hiring centre. The rates for hiring the machines/ implements are decided by the Village Climate Risk Management Committee (VCRMC) in NICRA project. In the CCA project, approach of custom hiring centre is the same but managed by a differently-named committee – village development committee (VDC).

Jaldoot, community-level extension professional: Jaldoot is a local person familiar with the local climatic conditions, cropping patterns and people. He acts as a local extension worker who has knowledge on all water-related activities. He helped the farmers in different activities involved in water budgeting, construction of water ponds, bore wells, etc. It was a good initiative undertaken by WOTR and it helped the farmers, mainly in how to plan their crops according to water availability. Any farmer who needs any information related to water can contact the Jaldoot. It is important for the drought areas where the main problem of farmers was water scarcity, so it is a good intervention done by WOTR to capacitate the farmers to deal with the changing climatic conditions.

Agro-meteorological advisory service: It provides location-specific agro-advisories on weather forecasting, associated agricultural advice and a phone-in help desk for farmers. For this purpose, local automated weather stations were set up in the villages and daily weather information was collected through GPS. After analysis, advisory services were provided to the farmers. On the basis of this, farmers plan their agricultural activities which help them to adapt to the changing climatic conditions.

Source: *Rupan et al 2018*

Case 13: Valorization of food waste for developing sustainable food value chains: Composting urban waste into agricultural inputs, Balangoda Urban Council, Sri Lanka

According to the European Commission's Emissions Database for Global Atmospheric Research, global food loss and waste generates 4.4 gigatonnes of carbon dioxide equivalent annually, or about 8% of total anthropogenic greenhouse gas emissions (EC 2012; FAO 2015). Minimizing or preventing food loss and waste at the source, as well as reusing safe and nutritious food waste as human food or for high-value non-food consumption (e.g., as animal feed, fertilizer or biomass), can reduce the negative economic and environmental impacts of food loss and waste.

In Sri Lanka, much of the solid waste is openly dumped into waterways and vacant fields in populated areas. Generally, municipal waste collection services are insufficient and only cover the urbanized and commercial areas of cities and towns. Most of the waste that is collected in Sri Lanka ends up in landfill sites, which are usually located close to streams, marshes or forested areas and can harm the environment and public health.

The Balangoda Urban Council in Sri Lanka is one of the oldest local administrations, dating back to 1939. As with many other cities, solid waste management was a key issue for the Balangoda Urban Council. Waste accumulation in the city caused many problems, including unpleasant odours, contamination of water bodies and paddy fields, and gave rise to diseases such as salmonella, typhoid fever, and diarrhoea. The main objective of the present administration is to build a green and environmentally friendly city by 2025, which includes a waste management project.

Although the composition of municipal solid waste (MSW) in Sri Lanka has a high proportion of organic matter, it also has a high moisture content at about 60 to 75%, and a low calorific value at about 1000 to 1200 kilocalorie per kilogram. Due to the low calorific value and high moisture content, the MSW composition is not viable for incineration for energy production. However, MSW with a high organic and moisture content has great potential for composting.

Like many other small- and medium-sized cities in Sri Lanka, Balangoda has introduced a compost plant – with government funding support – to recycle organic waste and produce compost for use in peri-urban and rural agriculture. Most of the compost plants have been established in peri-urban or rural areas, which facilitates the reuse of the compost produced in nearby agricultural areas.

In Balangoda, total MSW collection stands at 20 tons per day, with a 100% collection coverage. The garbage collected by the urban council is divided into non-degradable garbage (e.g., plastic and glass), which is sold, and non-degradable garbage, which is used to make compost. The compost plant project was initiated in 1999 as a city service to provide a solution to the solid waste management problem, but converted into a business later. Integrated waste management in Balangoda now consists of an MSW compost plant, a septage treatment plant, plastic pelletizer and an open dumping ground. The Balangoda Composting Plant recycles MSW, faecal sludge, fish waste, and slaughterhouse waste, with a capacity of 14 tons per day. In 2005, a waste-purchasing centre was built with support from the municipality to buy non-degradable waste from the city. In 2008, a night soil (i.e., human excrement that is collected at night from cesspools for use as manure) treatment plant was established. The current revenue stream of the plant is made up by the sale of the compost from MSW and 'super compost' from the night soil. The quantity of organic fertilizer produced by the plant has increased from 2,620 kilograms in 2003 to 385,660 kilograms in 2009. Income generated in 2009 from fertilizer sales (1,345,660 Sri Lankan Rupees [LKR]) was over hundred times the income generated in 2003 (13,100 LKR). The income collected by selling recyclable goods in 2003 was 75,450 LKR and increased in 2009 to 432,650 LKR (Cofie and Jackson 2013).

City dwellers benefit from the improved waste management system and reduced health risks as direct contact is much less with untreated waste in informal dumping sites. Farmers around Balangoda benefit from the production of organic fertilizers. This recycling of urban waste resources to benefit peri-urban and rural agriculture constitutes an effective strategy for operationalizing urban-rural linkages. The plant brings additional income to the municipality and the economic benefits are shared between the municipality and the seventeen plant workers.

In spite of the increased sales of compost, the compost produced by the project is not competitive with chemical fertilizers, which are heavily subsidized. A 50 kilogram bag of chemical fertilizer at the subsidised rate is cheaper than a 50 kilogram bag of the compost. As chemical fertilizers have a higher concentration of essential plant nutrients, the chemical fertilizer can be applied in smaller quantities than compost. The comparative advantage of the compost produced by the Balangoda plant lies in its ability to improve the quality of the soil, which is particularly important given the sandy soils in the province. Chemical fertilizers leach out of the soil without a soil conditioner, such as compost. Awareness raising and training to educate the public and farmers on the benefits of integrated waste management and the use of compost are indispensable for improving the uptake of this sort of initiative.

Source: *GIZ, FAO and RUAF 2016*

Case 14: Community Managed Sustainable Agriculture – Adaptation and mitigation in climate change

Community managed sustainable agriculture (CMSA) is practiced in the state of Andhra Pradesh in India. The CMSA approach replaces the use of chemical pesticides with a combination of physical and biological measures — including eco-friendly biopesticides — and complements it by adopting biological and agronomic soil fertility improvement measures leading to reduced use of chemical fertilizers. This has significantly reduced the cost of cultivation, the need for large amounts of credit, and indebtedness that results. These transformational changes have been achieved without any reduction in the productivity and yields for the participating farmers. Also it shows a significant net increase in farmers' incomes in addition to significant health and ecological benefits.

CMSA uses an institutional platform of community organizations(see figure 27) and their federations to plan, implement, manage, and monitor the programme and provide a single window approach for delivery of livelihood improvement services and enterprises, exclusively for small farm holders. CMSA is managed entirely by community institutions – federations of self-help groups (SHGs), with knowledge and capacity building services from Society for Elimination of Rural Poverty (SERP), which has supported and nurtured a powerful institutional model of federations of poor women. The process of mobilization starts with the poor organizing into SHGs of 10-15 members to form groups that save together and inter-lend small amounts of money to each other to stimulate household economic activity. The SHGs also collect repayment from the group members. It is this practice of collective thrift and credit that builds an asset base for the poor, disciplines them to work together and gives them confidence.

All SHGs in a village federate at the village level to form a Village Organisation (VO). Similarly all VOs in a mandal (a sub-district unit of about 30 villages) federate into a sub-district federation. All such federations in a district federate into a district federation.

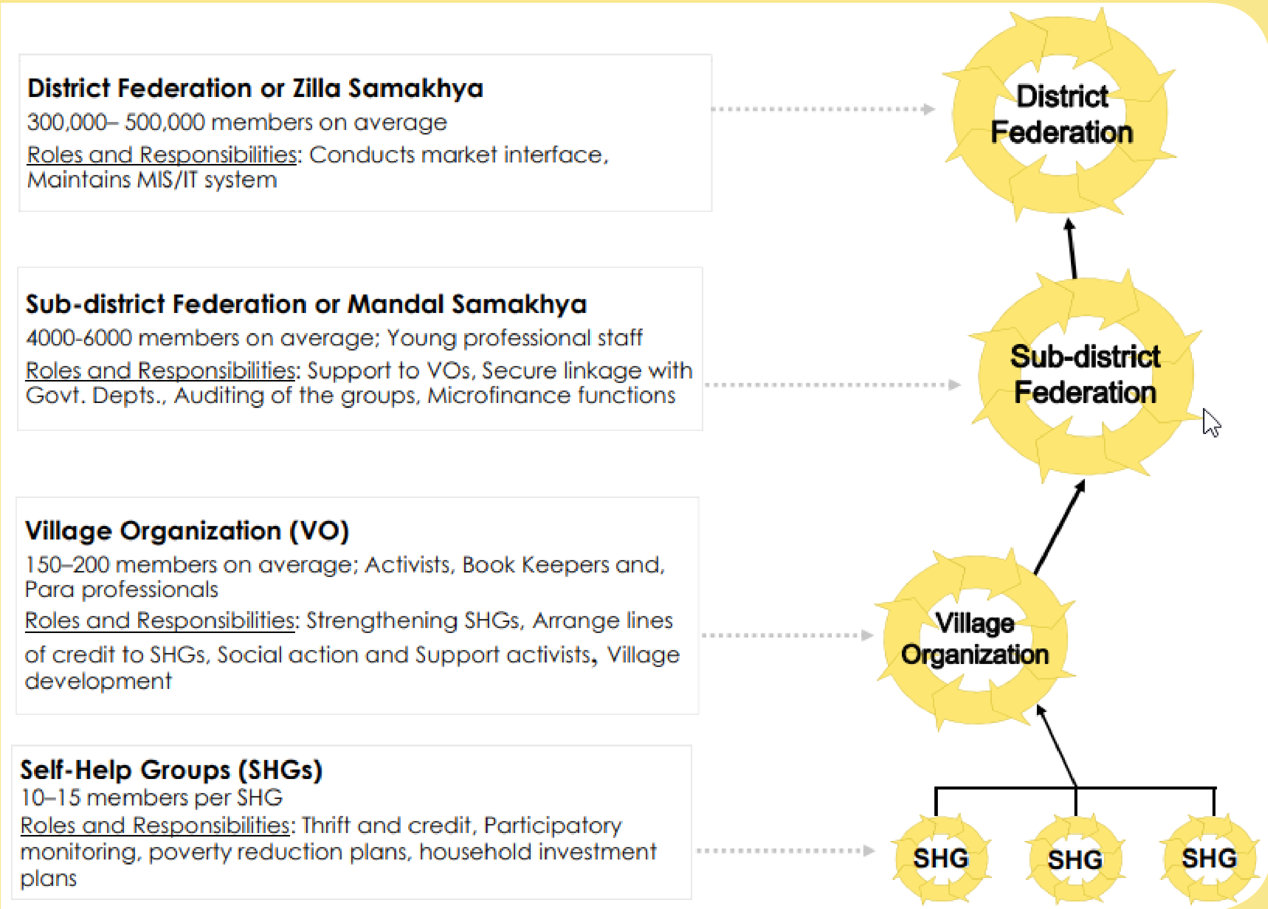

Figure 27: CMSA institutional platform

Technologies and Practices

CMSA technologies and practices are a mixture of scientifically proven methods, indigenous knowledge and traditional wisdom, and are deployed in a sequence which farmers learn during their training. The first stage of adoption of CMSA is based on the Integrated Pest Management (IPM) technology practiced in many parts of the world. Farmers undertake pest prevention and management training. They learn the diagnostic skills necessary to observe, document and understand the behaviour and life cycles of pests and the role of natural predators. Subsequently the farmers begin replacing chemical pesticides with a combination of physical methods such as pheromone traps and sticker plates, and biological methods such as bio-pesticides like Neem extracts. A generic list of the technology options for CMSA is given in Table 23 on the next page. In the third stage of CMSA, pest management through physical and biological means is complemented by measures to increase soil fertility. Farmers are encouraged to replace the use of conventional chemical fertilizers. This includes use of microbial formulations, intensive use of composting techniques, vermiculture and use of bio-fertilizers. CMSA practices are scaled up and intensified by replacing conventional fertilizers with tank silt, green manure crops, soil inoculation with Azospirillum and Azotobacter – nitrogen fixing bacteria – and vermicomposting. Farmers take on inter-cropping or multi-cropping to maintain soil fertility and reduce pest incidence. By the third year of operation farmers replace all chemical fertilizers and pesticides with sustainable technologies and practices. When these technologies and practices (CMSA) are introduced over large geographically contiguous areas, they lead to a large scale adoption of organic agriculture and involve certification, labeling, and developing of niche markets to satisfy consumer demands for organic products, and thus get higher prices compared to conventional agricultural products.

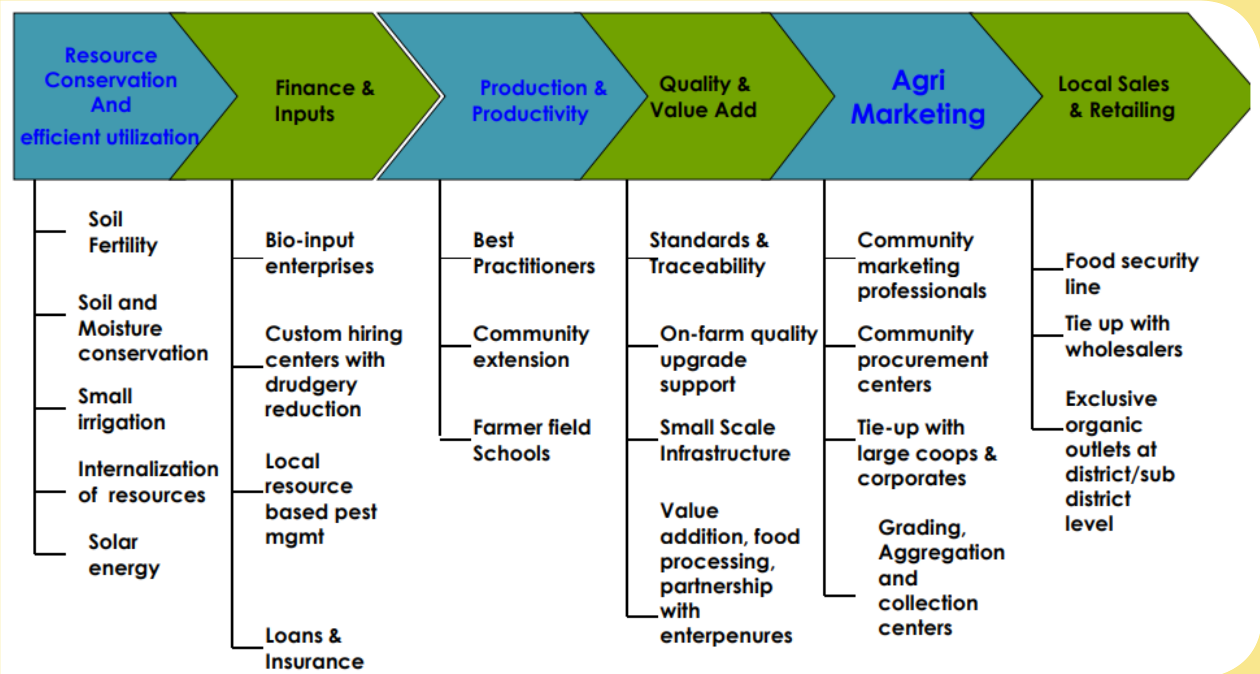

Figure 28: Climate smart interventions along eco-agri value chains

Extension through Farmer Field Schools

Farmer Field Schools (FFSs) are the main channel for delivery of extension services. Village Activists bring together all the farmers to attend weekly workshops in their own fields and training programmes to discuss issues related to sustainable agriculture practice. The training is provided to units of farmer SHGs. Each such SHG is a homogenous group, usually with contiguous land parcels, and participates in FFSs, facilitated by the VOs, for the delivery of extension services by Village Activists and Cluster Activist. In the first year of implementation, the focus is on replacing pesticide application and maintaining the yield. With success at this stage farmers move on to intensify sustainable practices and reduce external inputs. These FFSs create a local platform for experimenting and generation of localized technology solutions which are internalized by the participating farmers.

Table 23: Adaptation to climate change	
Effect of cli mate change	**CMSA adaptation method**
Increased droughts and floods	Mulching Conservative/dead furrow Crop diversity Improved drainage systems Selection of contingent crops Comprehensive drought-proofing
Extreme temperatures and diurnal variations	Multi-storied cropping based on photo candle light requirement
Increased incidence of pests and diseases	Building of pest ecology Managing pests by understanding them (NPM) Crop diversity
Decline in water resources	Rain water harvesting – Farm ponds Selection of crops Bund plantation – develops micro climate and reduces evaporation In situ moisture conservation Zero tillage SRI in paddy
Increased risk	Crop diversity – spreading risk Increased yield frequency Agro forestry
Soil nutrient depletion due to high temperatures	Soil fertility management by monocot/dicot crop combinations Mulching Azolla in paddy Creating enabling atmosphere for local deep burrowing earthworms Dung-based inoculants Recycling of biomass In situ soil fertility management Tank silt application Green manure crops Green leaf manure
Increased weed problems	Weed as a source of mulching

Table 24: Mitigating climate change	
Contributing factor for climatic change	**Mitigation method in CMSA**
GHG emissions	SRI in paddy Using biomass for composting rather than burning Eliminating chemical fertilizer use Aerobic composting methods like NADEP
Energy use	Low or no fossil fuels Animal power or human power No machinery using fossil fuels
Increased CO_2 in atmosphere	Bund plantation of green leaf manure and other plants

Technology Research and Development

The third step in the strategy is the development of a menu of technology options for pest and soil fertility management, based on the demonstrations and trials in farmers' fields. Farmers develop some of the technologies in situ, on their farms. After wider discussion with other farmers and with technical specialists at district and state level, the technologies are standardized and included in the training and resource material that is developed for the CMSA programme.

Scaling Up with Community Resource Persons

The role of Community Resource Persons (CRPs) is critical for the expansion of CMSA and making it popular. CRPs are farmers who practice CMSA and demonstrate that it is profitable and practicable for other farmers. Each CRP adopts three villages where they provide expertise on sustainable practices and recruit new practitioners of CMSA. They spend 15 days in a month in the three villages. The CRPs also identify farmers who show interest in practicing sustainable agriculture. Some of these farmers are shortlisted as CRPs after they gain first-hand experience and are able to demonstrate all the best practices effectively. These new CRPs then start working with new groups of farmers expanding the network of CMSA farmers. This practice has led to a rapid scaling up of the programme at a lower transaction cost and helped the programme acquire social movement characteristics.

Providing support on the Value Chain

The CMSA approach enables bundling of various services including credit, inputs, aggregation and value addition along the value chain at the farmers' doorsteps. Ultimately, the approach involves facilitating development of microcredit plans for sustainable agriculture and linking farmers to commercial banks. The CMSA approach also facilitates the farmer's access to high quality inputs through a network of community seed banks and agricultural implements from community centres. Enabling community organizations to conduct activities on value chain ensures higher quality and better prices for the produce. The institutional platform of the poor is used to invest in development of various livelihoods, and to manage enterprises along the value chain. These include investments in procurement centres for various agricultural commodities and milk, enabling small farm holders to grade their produce, aggregate them, and undertake quality control as well as do localized value addition. Likewise, at the sub-district level, federations invest in enterprises such as chilling centres for milk so as to increase the shelf life of the produce. Meanwhile the district level federation manages a number of support functions including running an insurance scheme for members through a network of call centres. All these activities together have resulted in higher price realization at the doorstep for small farmers and created a favourable eco system for profitable agriculture.

The benefits and impacts of CMSA

It is based on the premise that ecologically sustainable agriculture makes sound economic sense. It is anticipated that if this programme is implemented over a large contiguous areas, it could lead to significant adaptation to climate change, including lowering carbon footprint from reduced use of inorganic fertilizers and other ecologically sustainable practices. However, the increase in benefits through sustainable agriculture is accompanied by a trade-off in the form of increased investment in labour as some of the pest and soil fertility management methods recommended are more labour intensive. This aspect of CMSA makes it very attractive to small and marginal farmers, as they do not have to search for work outside their farms. Farmers are also able to meet this requirement by working together in groups as reduced pest infestation benefits all farms in a village.

Table 25: Benefits of CMSA

Economic Benefits	Environmental Benefits
▪ Lower cost of production & substantial state-wide savings ▪ Yield maintained or increased ▪ Higher household income ▪ Lower debt ▪ Higher cropping intensity ▪ Lower risk perception & higher investment in agriculture ▪ Business innovation & new livelihood opportunities	▪ Better soil health, water conservation ▪ Conservation of agro-biodiversity ▪ Fewer pesticide-related health problems ▪ Smaller carbon footprint as a result of reduced use & production of inorganic fertilizers

Exercises

Exercise 1

Group Exercise

Divide the participants into five groups and let each group think through on the cases given to them. Let them jot down the points that they have understood by analysing the case on chart/card, which can be presented in the plenum by the team leader of the group.

Climate Change Is Having A Massive Impact On Indian Farmers
Link to the video: https://www.youtube.com/watch?v=A8gcGaIzqIw
Farmer Climate School – Cultivating climate resilience
Link to the video: https://www.youtube.com/watch?v=hjdybT85Bwk
Climate Change Knowledge Network in Indian Agriculture
Link to the video: https://www.youtube.com/watch?v=mBIgdxVmxoQ
Shubh Kal (a better future): from Information to Knowledge and Action – Agroforestry
Link to the video: https://www.youtube.com/watch?v=B17vDfCU6aw
Climate Smart Village Project in India
Link to the video: https://www.youtube.com/watch?v=zH8wFwy_o0o

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Unit VIII:
EAS in Upscaling Climate Smart Agriculture

Objectives

- Understand the functions of EAS in up scaling CSA;
- Discuss the actions to upscale CSA.

Introduction

A number of organizations are generating new agricultural knowledge, but a wide gap persists between the knowledge generated and the knowledge used. Extension and Advisory Services (EAS) were established primarily to address this gap. It recognizes the importance of collaboration among multiple actors as well as the need for a broad range of functions and for the deployment of appropriate tools to upscale new knowledge. This unit tries to explore how EAS can be leveraged for up scaling purposes.

Discussion

EAS can play a very important role in scaling up Climate Smart Agriculture (CSA). Upscaling CSA will certainly entail changing the behaviour, strategies and agricultural practices of millions of agricultural producers, who need to become better informed about the impacts of climate change so that they can adopt better climate smart strategies. EAS have traditionally served as a bridge between research and farming, and supported farmers through the delivery of knowledge about new technologies. Yet the successful upscaling of CSA requires strategies that go well beyond changing farm-level agronomic practices. Indeed, it requires the identification and promotion of appropriate practices, technologies and/or models (new, improved, adapted) within favourable enabling environments, and needs to comprise constructive institutional arrangements, policies and financial investments at both a local and an international level (Neufeldt et al. 2015). EAS therefore need to be backed by comprehensive expertise and skills to foster interaction and encourage the flow of knowledge among a broader range of stakeholders than it does at present. The stakeholders in question include both those engaged in policy formation and those engaged in the actual practice of farming.

> The World Bank (2003) defines the purpose of up scaling (or scaling-up) as "to efficiently increase the socioeconomic impact from a small to a large scale of coverage'. Up scaling is the 'replication, spread, or adaptation of techniques, ideas, approaches, and concepts (the means)', and aims at achieving an 'increased scale of impact (the ends)'. It can occur horizontally, by replicating promising or proven practices, technologies or models in new geographic areas or target groups (e.g., Linn 2012); vertically, by catalysing institutional and policy change (e.g., World Bank 2003); and diagonally, by adding project components, altering the project configuration or changing strategy in response to an emergent reality. Up scaling can be effected either directly (a given organization is directly responsible for change), or indirectly (the organization influences change).

Functions of EAS to Upscale CSA

In order for EAS to achieve successful up scaling of CSA, they will need to encompass a broad array of different functions, as illustrated in Figure 29. EAS form an important part of the Agricultural Innovation System (AIS), and so EAS providers need to be able to identify, support, facilitate, and co-ordinate all existing and potential actors who can contribute to up scaling. That said, the up scaling of CSA knowledge is no longer a question of merely disseminating information or advising farmers on how to adopt a new variety, practice or product. Though this function remains important, it is a necessary but not sufficient precondition for achieving sustained impact at a scale, and to be fully effective it must be combined with several other equally/more important Innovation Management functions. So, apart from the need to develop the capacities of EAS providers to discharge the responsibilities already implicit in EAS, the functions of EAS itself need to be broadened (Sulaiman et al. 2018).

Building Partnerships

Up scaling CSA practices involve technical, institutional and policy changes. Several actors capable of bringing about the necessary changes already exist in the AIS, and EAS providers need to partner with them. Up scaling is a collective effort, hence the importance of building effective teams at different levels (field, meso and macro) when attempting to scale up CSA. It is therefore important to forge partnerships among the various AIS participants, be they from government, the private sector, an NGO, or a farmer organization engaged in research work, or, indeed, from any organization or group involved in knowledge intermediation, financing, policymaking, co-ordination activities, market intermediation (dealing with both inputs and outputs) or community mobilization.

Figure 29: Upscaling CSA

Closer Engagement with Research to Adapt Knowledge to Variable and Evolving Contexts

Up scaling CSA practices will necessitate the continuous adaptation of knowledge to calibrate it to diverse and evolving contexts. It follows that providers of EAS will need to engage much more with the research process than at present, for it is by now clear that no such thing exists as a universal product that can be upscaled everywhere. Clients and recipients need to be able to appraise and evaluate knowledge through on-station, on-farm and participatory research, and the results of the evaluations need to be fed back into the design and delivery of EAS, which will thus become more adaptive to circumstances. There needs to be much closer engagement between research and extension – beyond the routine interface meetings organized every year or at the beginning of each season. Research is essential for upscaling and for dealing with the new challenges that will emerge as innovation advances.

Long-Term Strategies and Funding for EAS to Support Upscaling

As up scaling even a single CSA practice takes several years, EAS need to be backed by far-sighted vision, a long-term strategy and sustained funding, and should include mechanisms for periodical reviews and modifications. This is not to say that every intervention has to last around 10 years, but as innovation advances, it will be necessary to have a strategy for securing additional support from different sources. In other words, EAS need to have inbuilt mechanisms for gathering information through a process of monitoring, evaluation and learning (MEL) that starts from the very beginning of the programme or project, and they also need a clear communication and knowledge-management strategy for the sharing of knowledge and propagation of learning. These include reviews, reflections, experience sharing workshops, negotiations among different groups, study visits, setting up resource centres, etc.

Evidence-Based Policy Engagement and Advocacy

Upscaling CSA practices definitely calls for political and financial support from governments. Several CSA interventions started out as pilots implemented by researchers, EAS providers, NGOs and the private sector, but upscaling only really happened when the practices became a state/national policy and started receiving public investments and programmatic support from state agencies.

Actions to Promote Upscaling CSA

1.	Convening	setting up platforms for stakeholder interaction and forming networks of strategic partners;
2.	Facilitating	dialogue and the exchange of knowledge among operational partners;
3.	Organizing	joint events for implementing specific activities, and setting up user/client groups;
4.	Training	farmers, knowledge-intermediaries and service-providers from the public and private sector, civil society and NGOs;
5.	Provisioning	of incentives, inputs and infrastructure to encourage adoption and partnerships;
6.	Sharing knowledge	and experiences to hone policies and practices;
7.	Disseminating information	on new knowledge/practices/products through various media channels and person-to-person outreach;
8.	Undertaking adaptive research	through on-station and on-farm trials and participatory action research;
9.	Advocating	for policy recognition, greater public investments and the harmonization of laws and guidelines to accelerate the process of upscaling.

Source: *Sulaiman et al. 2018*

Tools to Support Upscaling

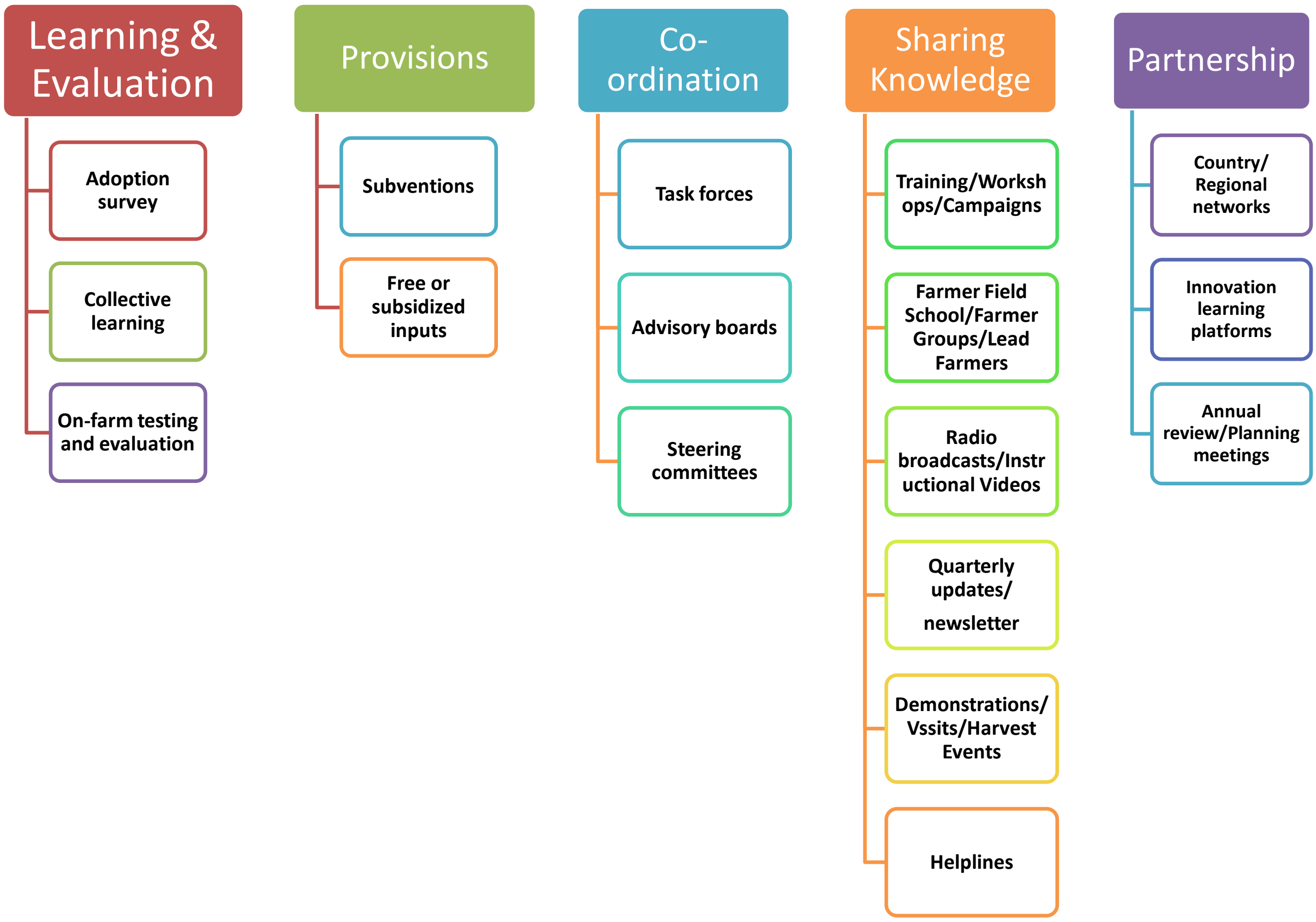

Figure 30: Tools supporting the up scaling of CSA

It takes a wide range of different actors to carry out the various Innovation Management functions that the upscaling of CSA demands. If EAS are to contribute significantly to the upscaling of CSA, the providers of the services need to broaden their mandate, partner with other relevant AIS actors, deepen their level of engagement with the research aspects, prepare for a long-term effort, and seek to influence the enabling environment through policy advocacy.

Conclusion

This unit aimed to draw lessons for EAS, on the following three aspects: the functions, actions, and tools used by the different actors to upscale new knowledge on CSA.

Cases

Case 15: Conservation agriculture in Zambia

Practice

Conservation agriculture (CA) refers to a combination of crop production practices that include minimum tillage, mulching, the use of composite and green manure, planting in pits and intercropping, crop rotation, and integrated crop management. CA as practiced in Zambia consists of the application of five key principles: (i) reduced tillage on more than 15% of the field area without soil inversion; (ii) the precise digging of permanent planting basins or the preparation of soil with a 'Magoye Ripper' (where draft animals are available); (iii) the leaving of crop residues in the field (no burning); (iv) the rotation of cereals with legumes; and (v) dry-season land preparation.

Context

In Zambia, CA methods were promoted and adopted for two main reasons. First, as very few small- and medium-scale farmers use irrigation systems, most are highly dependent on rains in a country that has experienced periods of drought. To remain productive in the face of climate challenges, Zambian farmers need to adopt viable and more sustainable methods. Second, following the removal of subsidies for agricultural inputs, which rendered intensive farming unaffordable for most small- and medium-scale farmers, CA technology turned out to be a cost-effective way of maintaining the same level of productivity.

Adoption

As of 2015, approximately 350,000 small-scale farmer households in Zambia (41% of the national total) were practicing forms of CA on an area of almost 175,000 ha, which corresponds to 0.5 ha/farmer (see Table 26). Between 2000 and 2015, the number of participating farmers and the amount of land under CA management grew almost 12-fold.

Table 26: Extent of adoption of CA in Zambia in the last 10 years

Attribute	Units	Small-scale (< 2 ha)				Large-scale (> 2 ha)				Total (2015)
		2000	2005	2010	2015	2000	2005	2010	2015	
Estimated number of smallholders practising CA	Number	30,000	78,000	250,000	350,000		15	150	200	350,200
Estimated amount of land under CA	Hectares	7,500	19,500	125,000	175,000		150	1,500	2,000	177,000
Estimated percent of farmers adopting CA	Percent			16	20-25				17	41

Source: *Mwanza 2016*

Actors and their roles

Since 1996, the Conservation Farming Unit (CFU) of the Zambia National Farmers Union (ZNFU) has been involved in the promotion of CA. Apart from CFU, several other actors also supported the generation, adaptation, promotion, and use of CA in Zambia. They include the Institute of Agricultural and Environmental Engineering (IMAG), the Golden Valley Agricultural Research Trust (GART), the Dunavant Cotton Company, the Cooperative League of the USA (CLUSA), and the Land Management and Conservation Farming Project (LMCF), together with their partners at the extension service of the Ministry of Agriculture and Cooperatives (MACO), and NGOs such as the Catholic Archdiocese of Monze, Development Aid from People to People (DAPP), CARE and Africare.

Donor support

Several donors supported CA projects in Zambia, including the Swedish International Development Cooperation (SIDA), the Canadian International Development Agency (CIDA), the World Bank, FAO, the EU, and the Governments of Norway (NORAD) and Finland. Norway has funded the Conservation Agriculture Scaling-up Project (CASPP), implemented by the Ministry of Agriculture and Cooperatives (MACO). CFU received private sector support from the Lonrho Group, while the World Bank funded the Agricultural Sector Investment Programme (ASIP) through MAFF, which is involved in carrying out on-farm trials with maize and cotton farmers of the Central and Southern Provinces.

Role of the private sector

The private sector played a very important role in promoting CA in Zambia. Private cotton companies worked closely with CFU to train out-growers in CA practices, using a lead farmer model, mainly in the cotton belt of the Central Province. For instance, Dunavant provided training programmes and market (purchasing price) incentives for CF best practices. A number of CA-related research activities are being carried out at GART in response to critical CA demands in Zambia. The programmes deal with conservation agriculture, seed multiplication, smallholder dairying, village poultry and biofortification. GART was also one of the main stakeholders of the CASP project for the up scaling of CA technologies.

The Conservation Agriculture Programme (CAP) promoted the direct engagement of the private sector and agro-dealer networks. CAP also worked closely with GART on research, and with the Zambia National Farmers' Union (ZNFU) on the Production, Finance and Improved Technology (PROFIT) programme relating to the private sector. Most notably, CAP also configured a lead farmer extension and training system, which included a field officer who was in charge of 13-15 regions and oversaw field coordinators (FCs) and contact farmers (CFs). Each field officer was responsible for mobilizing his/her group of 30 farmers for the training sessions, which were conducted in the field by the FCs. In this way, FCs and CFs 'work' for the Conservation Farming Unit, and are paid for their services with electronic vouchers.

Zambian farmers received incentives to promote CA. Under CAP, redeemable input vouchers of substantial value (sometimes USD 100 per lead farmer) were provided. Community Markets for Conservation (COMACO) evolved from the idea that the aid-dependent rural poor in Zambia could partner with a company to sustain their livelihood. In exchange for agreeing to use conservation farming techniques, farmers were given access to farming inputs and training to improve their skills, and were guaranteed a high market value for their goods. In a further notable example of private sector participation, Zoona, an electronic payments company based in Zambia, partnered with Dunavant Cotton Company to make e-voucher payments ('ag vouchers') to smallholder farmers in exchange for their goods.

NGOs

Ever since CA programmes began in Zambia, several NGOs have promoted it by supplying inputs (CARE, CRS, PAM), mobilizing groups (clubs), offering services through Development Aid from People to People (DAPP), delivering training courses through the Kasisi Agricultural Training Centre (KATC), facilitating private sector participation though Musika (Musika is a Zambian non-profit company that works to stimulate private sector investment in the smallholder markets), and fostering value chain development through Community Markets for Conservation (COMACO).

In collaboration with the national Crop Research Institute (CRI) and a private company, the Sasakawa Global 2000 (SG 2000) project (the SG 2000 project was initiated in Ethiopia during the spring of 1993; it aimed to upgrade the capacity of the extension services to disseminate proven research technology to small-scale farmers) developed a 'no-till with mulch' cultivation system that is especially well-suited to small-scale farmers. Although the CA projects of the NGO are based in Ghana, the CA technology packages were widely adopted by the farmers of Zambia. Musika has a single objective, which is to stimulate private sector investment in smallholder markets to which end it has supported the e-voucher programme of the Zambian Government to improve the distribution of subsidized inputs to smallholder farmers. The DAPP Farmers' Club project seeks to raise the living conditions of rural families by increasing and diversifying production and improving marketing. Farmers' Club members are given training sessions, instructed in model farming, and receive field visits. They receive the benefits of low-cost technical solutions and technical assistance, and enjoy the opportunities flowing from the exchange of collective experiences, links to micro financing and markets, and, generally, from the support that club membership implies.

COMACO forms business partnerships with rural communities and links villagers to urban consumers through a value chain of environmentally smart products. It offers solutions for land management, food security, and improved rural incomes. The Kasisi Agricultural Training Centre (KATC) offers a range of courses relating to sustainable organic agriculture (SOA) for, among others, small-scale farmers, school teachers, extension staff, community-based extension workers and leaders. KATC also verifies the results of trials of both indigenous and exotic technology, and conducts technology-generation trials in which new farming ideas are tested. Many NGOs, including the Catholic Archdiocese of Monze, Development Aid from People to People, CARE and AFRICARE, have also involved themselves in the extension of CA technologies. The association of NGOs with agribusiness firms is to be welcomed because it produces a high degree of complementarity, as evidenced by the partnership between CLUSA and Cheetha paprika growers. (In Zambia, Cheetah Ltd processes and exports paprika as the primary ingredient in food colouring. It is the largest processor of paprika in Zambia. Paprika is a high-value, quality-sensitive but nonperishable crop.)

Policy support

In 1998, the Ministry of Agriculture, Food and Fisheries (then MAFF, now renamed MACO) formally embraced conservation farming as an official policy of the Zambian Government. Their partners at LM&CF likewise stepped up promotional efforts for both CF rippers and hand-hoe basins. Consequently, both MAFF and LM&CF have devoted increasing attention to extending conservation farming technologies. MACO currently hosts the Secretariat of the National Conservation Agriculture Task Force.

In 2004, the Government of Zambia recognized conservation farming as an important component of the national strategy for increasing crop production, as set forth in its National Agricultural Policy. The sixth National Development Plan (2011-2015) cites CA as part of the government strategy for climate-change adaptation and mitigation, diversification, the attainment of national and household food security, and soil management for sustainable agricultural production and growth. The CA scaling-up (CASU) initiative, which was started in 2013 with EU/FAO support and implemented by MAL through its extension services in Zambia's provinces, is expected to extend the outreach of CA practices to more than 300,000 small-scale farmers.

Source: *Sulaiman et al. 2018*

Case 16: System of Rice Intensification in Vietnam

Practice

The System of Rice Intensification (SRI) is a climate smart agro-ecological methodology for increasing the productivity of rice (and more recently other crops) by changing the manner in which plants, soil, water and nutrients are managed. The SRI methodology is based on four interlocking key principles: (i) early, quick and healthy plant establishment; (ii) reduced plant density; (iii) improved soil conditions through enrichment with organic matter; and (iv) reduced and controlled water application.

Context

In Vietnam, rice is grown on 85% of cultivated land. Rice production in the country has been continuously rising, from 25 million tons in 1995 to almost 40 million tons in 2010. Part of the increase is attributable to the expansion of land under cultivation, and part to higher yields, which improved from 3.7 tons per hectare in 1995 to 5.3 tons per hectare in 2010. While the higher yields were made possible partly by the use improved seeds, they also reflect the increased use of fertilizer, herbicides and pesticides, to the detriment of the environment and community health. The Vietnamese Government is a major provider of farming services, and controls access to inputs and credit. Farmer groups – consisting of 20 to 30 families – operate in rural villages, and are organized and trained by agricultural technicians and extension agents.

Actors and their roles

In 2003, Vietnam's Plant Protection Department (PPD) began conducting SRI training sessions as part of its FAO-funded integrated pest management (IPM) programme. The training, delivered through farmer field schools (FFS), enabled participants to trial SRI in experimental fields and witness first-hand the potential of the method. Follow-up trials in additional areas were funded by the Biodiversity Use and Conservation in Asia Programme (BUCAP) and the Danish International Development Agency (DANIDA). In 2004, PPD developed and disseminated technical guidelines for SRI adoption for different rice cultivation conditions. Using some of the resources earmarked for the IPM component of the DANIDA-funded Agricultural Sector Investment Programme, in 2005-06 SRI was tested on larger tracts of land, of 2-5 ha, in 12 provinces. In 2006, Oxfam, the PPD, the Centre for Sustainable Rural Development (Vietnam) and the Hanoi University of Agriculture formed an SRI-extension partnership that emphasized experiential learning and knowledge sharing. The first phase of their joint extension programme tested SRI in various local contexts both with a view to building up a solid base of evidence-based knowledge and with a view to helping farmers and local technicians adapt SRI principles to their particular circumstances.

In 2007, the Ministry of Agriculture and Rural Development (MARD) issued a formal decision acknowledging SRI as a 'technical advance' and directing government agencies to 'guide and disseminate' the innovative methodology. In the same year, the PPD, with the support of Oxfam America, launched an SRI dissemination effort in Ha Tay Province, and in one year, increased the use of SRI there from 3,000 ha to 33,000 ha. The community-based SRI model was also successfully rolled out on 170 ha located in the Dai commune. Oxfam America also supported initiatives such as 'The System of Rice Intensification (SRI): Advancing small rice farmers in Mekong region' in 2007, and the 'Farmer-Led Agricultural Innovation for Resilience' (FLAIR) of 2010-2022.

In 2009, the PPD with the support of Oxfam America and Oxfam Quebec and the assistance of the Centre for Sustainable Rural Development (SRD), launched an SRI programme in 12 communes in six provinces involving coordinated action between local rural organizations, local government, service-providers and farmers. The PPD also raised funds from the provincial government for field-level implementation.

In 2015, SRIViet, a foundation for organizations and individuals interested in SRI, was established in Vietnam. The founding members include Oxfam, SNV (a Dutch non-profit international development organization), Thai Nguyen University (ICC-TNU), the Field Crops Research Institute (FCRI), the Center for Agrarian System Research and Development (CASRAD), the Institute of Agricultural Environment (IAE), Vredeseilanden in Vietnam (VECO), the Foundation for International Development/Relief (FIDR), PPDs and the Centre for Sustainable Rural Development (CSRD). SRIViet arranges and leads regional exchanges, dialogue sessions and collaborative work among national SRI networks in the Southeast Asia region. The foundation brings together organizations and individuals interested in SRI and sustainable rice systems so that they may share information and research findings, cooperate on ways of giving greater voice to rice producers, and work together on policy advocacy and the mobilization of support.

The long-term investments and policy advocacy work of PPD and Oxfam furthered the expansion of SRI by securing political endorsement and backing. At the start of 2011, the government allocated USD 383,000 to support SRI and foster other low-input, low-carbon agricultural methods in the six provinces included in the programme. The Government's allocation was one-third higher than the total value of Oxfam's contribution.

Impact

By 2009, 440,833 farmers in 21 provinces were using SRI methods on 232,365 ha, of which 85,422 ha saw production during the winter-spring season, and 146,943 ha during the summer season. The Ministry of Agriculture and Rural Development reported that more than a million farmers (1,070,384 of which 70% were women) were applying SRI methods on 185,065 ha (457,110 acres). By 2011, one million farmers, some 10% of the national total, had adopted SRI and were following all, or some, of its principles. The PPD reported that the SRI methodology was being used on 16% of the rice-growing fields in the north of the country, and on 6% of the rice-growing fields in the country as a whole. SRI farmers increased their collective income by USD 18.35 million (VND 370 billion) in the spring crop season of 2011. As of 2015, SRI had reached over 1.8 million people.

Source: *Sulaiman et al. 2018*

Case 17: Drought-tolerant maize in sub-Saharan Africa (DTMA)

Practice

Maize is a major staple in sub-Saharan Africa (SSA), with over 300 million people depending on the crop for their food security and livelihood. Maize production in Africa is almost completely rainfed, and droughts ravage approximately a quarter of the crop, resulting in losses of up to half the harvests in affected areas. Extended periods of drought adversely affect not only crop yields but also the livelihoods of African farmers. Based on technological breakthroughs in the 1990s and a strong breeding programme on drought tolerance initiated by the International Maize and Wheat Improvement Center (CIMMYT) and subsequently continued by the International Institute for Tropical Agriculture (IITA), more than 200 DT maize varieties have been developed and released across SSA over the last two decades. Intensive efforts to strengthen SSA maize seed systems, including through public-private partnerships and the capacity development of national agricultural research systems (NARS) and seed companies, led to the introduction of DT maize varieties in 13 SSA countries, and thus offset the failure of the market to scale up DT varieties.

Context

Around 40% of maize-growing areas in the region face occasional drought stress and suffer yield losses that are 10-25% above non-stressed areas, while an additional 25% of the crop suffers frequent drought, with losses of up to 50%. Launched in 2006, the Drought Tolerant Maize for Africa (DTMA) project aimed to mitigate drought damage and other constraints on maize production in sub-Saharan Africa, and thus increase yields by at least one ton per hectare under moderate drought conditions, corresponding to a 20-30% increase over current yields, which will thus benefit 30-40 million people in 13 African countries. The project has been jointly implemented by CIMMYT and IITA, with the close collaboration of the national agricultural research systems (NARS) of participating nations. Millions of farmers in the region are already benefiting from the partnership, whose outputs include support and training for African seed producers and the promotion of vibrant, competitive seed markets.

Impact

In 2016, more than 100 seed companies (local, regional and international) upscaled elite DT maize varieties in SSA, with more than 60,000 tons of certified seed of DT maize varieties delivered, covering nearly 2.75 million hectares and benefitting an estimated 6 million households, or 53 million people. At least 60% of the beneficiaries were women and children. The project in its entirety will benefit approximately 30-40 million people in 13 or more countries in Africa by raising yields by at least one ton per hectare, even in periods of moderate drought. Figure 31 depicts the cumulative growth in the number of DT maize varieties over the years. For the time being, DT maize covers less than 3 million hectares out of the total of 35 million hectares. Accordingly, SSA has tremendous potential for further upscaling and for deploying elite climate resilient maize varieties.

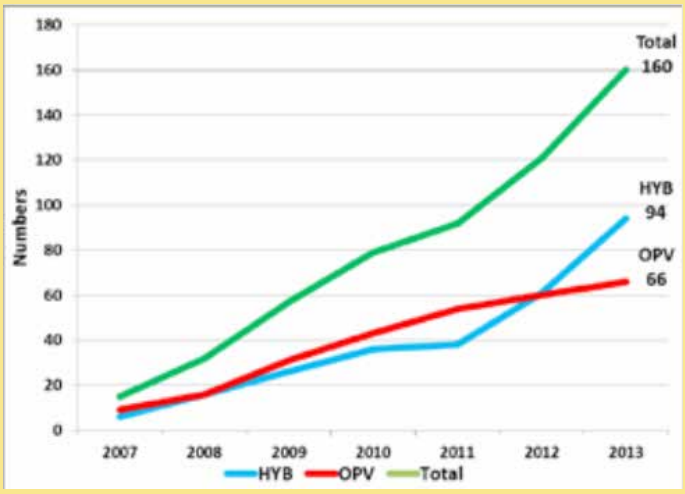

Figure 31: Cumulative numbers of drought-tolerant maize varieties released under the DTMA project between 2007 and 2013 (HYB: Hybrids, OPV: Open pollinated variety)

Source: *DT MAIZE 2014*

Table 27 below depicts the DT seed multiplied in the SSA countries in 2012, which invariably contributed to the upscaling of DT maize.

Table 27: Drought-tolerant seed multiplied in DTMA countries in 2012

Country	Quantity (MT)			Area covered (000 ha)*	Households covered (000)*
	New	Old	Total		
Angola	511	0	511	20	51
Benin	45	0	45	2	4
Ethiopia	0	1,544	1,544	62	154
Ghana	55	0	55	2	6
Kenya	0	5,050	5,050	202	505
Malawi	4,385	31	4,416	177	442
Mali	800	0	800	32	80
Mozambique	855	0	855	34	86
Nigeria	735	0	735	29	74
Tanzania	619	1,757	2,376	95	238
Uganda	527	1,045	1,572	63	157
Zambia	3,331	91	3,422	137	342
Zimbabwe	4,961	2,507	7,468	299	747
Total	16,824	12,025	28,848	1,154	2,885

Source: *Drought Tolerant Maize for Africa Initiative 2015*

Table 28: Actors and their Roles

Actors	Roles/Functions	Activities
CGIAR Centers (CIMMYT and IITA) and CGIAR Research Program Maize (CRP-Maize)	Development and deployment of elite DT, disease-resistant and nutrient-use efficient maize varieties adapted to diverse production environments in SSA. Collaborating with other research-focused partners such as the Syngenta Foundation, the University of Hohenheim, etc. CIMMYT develops and deploys maize germplasm with high yield, stress resilience and nutritional quality. The CGIAR Research Program 'MAIZE' is an international collaboration between more than 300 partners from the public and private sectors, national institutions, international research organizations and seed companies. This unique partnership seeks to mobilize global resources in maize research and development in order to achieve greater strategic impact on maize-based farming systems in Africa, South Asia and Latin America.	Formation of maize breeding and seed system teams. Development of more than 200 maize varieties/hybrids. Intensive capacity strengthening of: » NARS institutions in breeding climate-resilient maize varieties; » SME seed companies in DT maize seed production; » Seed road map implementation; » Upscaling and marketing in target agro-ecologies. Coordinated the mother-baby trial system in southern and eastern Africa as a means of generating farmer participation in varietal selection, adoption and production along with seed companies and NARS. Systematic collaboration with NARS and farming communities for participatory, on-farm selection of seed varieties. The introduction of the annual 'Best Maize Breeding' and 'Technology Dissemination Team' awards in 2007 to recognize output orientation and teamwork. Workshops/meetings for the country launch of drought-tolerant maize for Africa seed scaling (DTMASS). The workshops raise awareness about DTMASS and offer opportunities for the planning of activities. Several seed companies have undertaken to contribute to the capacity development of producers. Seed systems annual meeting. A presentation was made on the progress achieved by various projects in seed systems research and development across Africa and farther afield.

DTMA Project Innovation Learning Platform (ILeP)	The ILeP is led by the Ministry of Agriculture and Food Security, and involves national maize breeders and extension agents, private and community seed producers, agro-dealers, grain marketing companies, microfinance institutions, non-governmental organizations and farmers, all of whom collaborate across the entire maize value chain.	By linking with the country's Agricultural Input Subsidy Programme, ILeP has enabled more farmers to access ZM 309 seed, and grow the variety in six of the most drought-prone districts of Malawi, thus contributing to improved food security for thousands of farming households.
Bill and Melinda Gates Foundation (BMGF)	Fostering sustainable agricultural practices. Strategic partnerships and advocacy. Access and market systems.	Funding for scaling up the development of improved DT maize hybrids/varieties, delivery of DT maize seed across SSA. Allocated grants to the Stress-Tolerant Maize for Africa Project. Funded the IMAS project. Organized workshops for project participants.
Seed company partners	Promoting the use of high-quality improved seed and planting materials that conform to national and international standards. Upgrading the knowledge and skills of members engaged in the production, distribution and commercial trade of seeds. Providing a forum for the exchange of information and facilitating communications among members and seed-chain actors. Engaging in dialogue and lobbying for the harmonization of the seed policies, laws and regulations of the region.	Stocking of drought-tolerant seeds. Scaling and marketing of maize varieties. Partner in the implementation of DTMASS project.
United States Agency for International Development (USAID)	Investing in cutting-edge scientific and technological agricultural research. Developing sustainable agriculture strategies. Offering extension services.	Funded the DTMASS project to scale up seed availability in select countries. Funded the IMAS project.
Kenyan Agricultural Research Institute (KARI)	Conducting research in crop and livestock production and marketing. Improving livelihoods and commercializing agriculture by increasing productivity and fostering value chains.	KARI has set up local facilities for doubled haploid (DH) production from tropical and sub-tropical maize germplasm. The Ministry of Agriculture and KARI set up a precise drought-screening site in Kiboko, Kenya for the evaluation of 5,000 new DT varieties per year. Organized training workshops for maize technicians (seed companies, NGOs, CIMMYT field stations) as part of the DTMA project.
Seed Enterprise Management Institute (SEMI)	Set up in March 2010, SEMI seeks to alleviate food insecurity by expanding the capacities of the seed supply chain in SSA.	Training modules that focus on: seed production, drying, processing, conditioning and storage; seed testing and quality assurance; seed marketing and business management; seed policies and regulations; information management. Courses in seed production, drying, processing and storage for representatives of seed companies operating in 13 SSA countries.

The Kenya Plant Health Inspectorate Services (KEPHIS)	Seed inspection and certification body in Kenya. Phytosanitary services. Seed certification servicers.	Viability testing of the newly developed improved seed varieties at the national performance trials (NPT) of KEPHIS. Organizing field days. Dissemination of information on plant health management.
Farmer Voice Radio (FVR)	FVR is a consortium of radio broadcasters, agricultural experts and farmers, who provide a variety of agriculture-related radio programming, and serve as a megaphone for two-way extension priorities from content providers.	FVR produces a series of radio programmes whose content is developed collaboratively by experts, farmers and radio extension officers. The DTMA project generated content and provided expert interviews.

Source: *Sulaiman et al. 2018*

Case 18: Agriculture and Climate Risk Enterprise (ACRE), East Africa

Practice

ACRE Africa, the brand name used by Agriculture and Climate Risk Enterprise Ltd (ACRE), is a registered insurance surveyor in Kenya and an insurance agent in Rwanda and in Tanzania. ACRE links insurance to credit arrangements tailored to farmers who wish to improve their crop and/or dairy production. Farmers can take out policies against undesirable weather events such as delayed or excess rainfall and drought. Farmers need to apply for insurance cover before planting, must specify their physical location, acreage, and the risks they want to insure against, and must pay an appropriate premium to the insurance company. In the event of loss, the insured farmer will be compensated.

There are three pillars to ACRE's approach

The first is made up of a broad array of insurance products that are based on several data sources, including automatic weather stations and remote sensing technologies.

The second is ACRE's role as an intermediary between insurance companies, reinsurers and distribution channels/aggregators, which include microfinance institutions, agribusiness and agricultural input suppliers. This second pillar provides a link to the mobile money market, particularly the M-PESA scheme in East Africa, which allows quick enrolment and the rapid payment of claims without the need for physical visits to farmers. In this way, the programme can quickly reach the many millions of farmers enrolled in M-PESA.

The third pillar, index insurance, is a relatively new but innovative approach to insurance provision. It pays out compensation on the basis of a predetermined index (e.g., rainfall level) for the loss of assets and investments caused by the weather or catastrophic events, and do not require the traditional services of insurance-claim assessors. Indexes have been developed for maize, beans, wheat, sorghum, millet, soybeans, sunflowers, coffee and potatoes.

Context

The ACRE insurance scheme addresses the problem of farmer vulnerability to weather unpredictability. In particular, drought or excess rain can devastate crops, not only ruining a farmer's harvest for that year but also affecting prospects for recovery in the future. The Syngenta Foundation wanted to develop an insurance product that could reach small-scale farmers yet still be economically sustainable, and found that an index-based product was most apt for this purpose. The product is structured so that premiums and pay-outs are calculated by comparing actual data to an index based on historical data. Typically, this is done through the use of rainfall measurements from local weather stations, whose reports are compared against the minimal amount (the trigger level) of rainfall necessary for normal plant growth. This design was seen as advantageous because it relied on objective measurements to determine damage. The Syngenta

Foundation for Sustainable Agriculture launched ACRE in June 2014 as a commercial company advising African smallholders on crop protection strategies.

Impact

ACRE, which covered about 233,000 farmers in East Africa in 2014, and 400,000 small farmers in Kenya, Rwanda and Tanzania in 2015, is projected to reach 3 million farmers across 10 countries by 2018. Its rapid advance is charted in Figure 32 below. In 2013, the total sum insured reached USD 12.3 million and pay-outs of USD 370,405. The average cost of insurance was 5-25% of harvest value. After two years of offering index-based agricultural policies in Kenya, Syngenta surveyed 455 farmers with cover and 181 without. The results revealed that insured farmers invested 16% more in their farms than their uninsured counterparts.

Progress of ACRE in East Africa

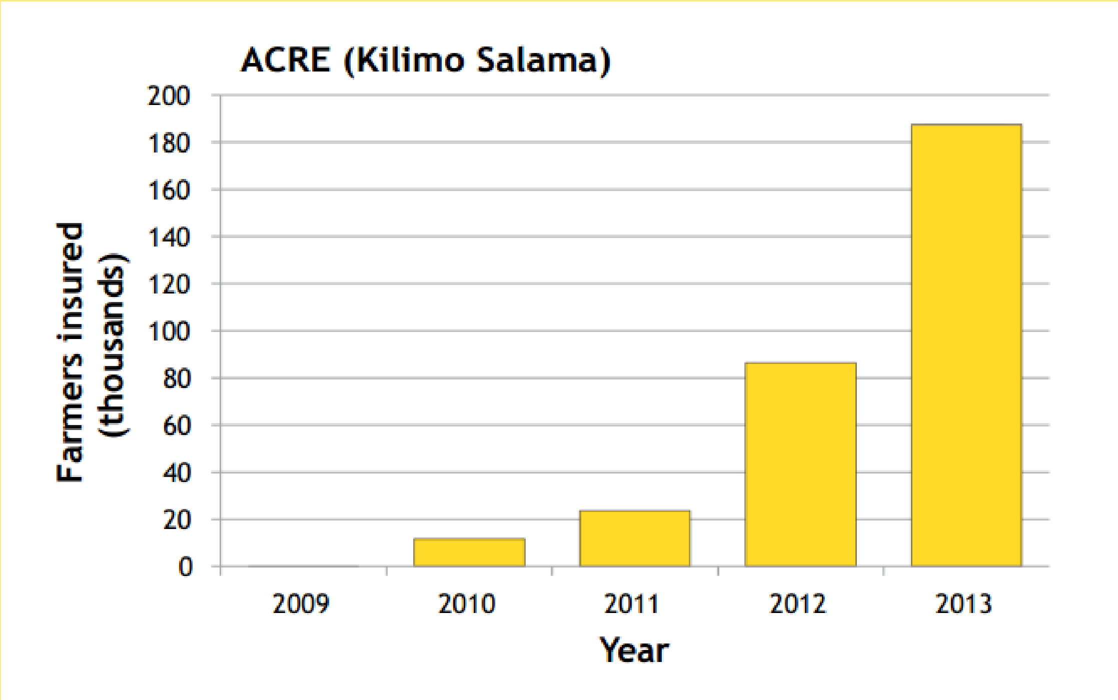

Figure 32: Number of farmers covered by the ACRE programme in East Africa. (Data from ACRE 2014.)

Source: *Greatrex et al. 2015*

Of the farmers insured by ACRE in 2013, 97% also received loans linked to their insurance cover. Having insurance increased the likelihood that growers would invest more in agriculture, even in the face of impending risks.

Actors and their roles

ACRE evolved from the Kilimo Salama project (established in 2009), which was funded by the Syngenta Foundation and the Global Index Insurance Facility (GIIF). ACRE was launched in partnership with Safaricom (the largest mobile network operator in Kenya) and UAP (a large insurance company based in Kenya). Kilimo Salama is an index-based insurance plan that covers farmers' inputs in the event of drought or excessive rainfall. It helps farmers avoid the risks associated with rainfall variability that directly affect their livelihoods. The product is index-based, meaning pay-outs are determined on the basis of a comparison with historical, regional rainfall patterns. It is supported by an 'in-house knowledge hub' of 30 local and international specialists, who work on all aspects of the plan, from designing the reference index to distributing the product and educating farmers.

In 2012, Access to Finance Rwanda (AFR) and the Ministry of Agriculture and Animal Resources (MINAGRI) contracted the Syngenta Foundation for Sustainable Agriculture (SFSA) to carry out a feasibility study on the development of crop and livestock insurance in Rwanda. For the study, 10 crop value chains were analysed for their commercial potential and insurance viability, and were then grouped according to their potential. Livestock came second after maize, in order of importance, thus narrowing down the number of priority value chains. ACRE Rwanda worked with farmers, cooperatives, aggregators, government officials, and stakeholders along the priority value chain.

Distribution channels of ACRE

In Kenya, Kilimo Salama insurance is distributed through local stockists of farming inputs, which makes it easier for customers to acquire the new product. The distribution channel capitalizes on existing relationships, since farmers are more likely to take advice from someone they know and trust. Currently ACRE uses the following channels for the placement of its insurance products (Table 29).

Table 29: Distribution channels of ACRE

Financial Institutions	▪ Community-based Organizations ▪ Savings and Credit Cooperatives ▪ Banks ▪ MFIs Savings & Loans Groups
Agribusinesses	▪ Traders ▪ Chemical companies ▪ Seed/fertilizer suppliers ▪ Marketers/off-takers ▪ Processors ▪ Exporters ▪ NGOs/Donors ▪ Commercial farmers
Retail Business	▪ Insurance Brokers & Agents ▪ Vets ▪ Agro-vets ▪ Farmer associations

Source: *Sulaiman et al. 2018*

Case 19: Green Savers Association in Dhaka, Bangladesh: A sustainable agriculture association focused on promoting urban agriculture and creating green spaces in the city

In the 2018 Environmental Performance Index report, Bangladesh was ranked 179 of 180 countries. This low ranking is based on the country's limited capacity to curb environmental pollution, for example by improving air quality, protecting biodiversity and reducing greenhouse gas emissions (Wendling et al. 2018). The Environmental Performance Index is also a partial indicator for extreme vulnerability to climate change. The country is already experiencing the impacts of climate change, such as sea-level rise, more frequent and more intense cyclones and droughts, increased flooding and soil salinization. Large numbers of people in Bangladesh have been displaced mainly as a result of these impacts.

Initiative Profile

The Green Savers Association, which was founded in 2010, works to enhance the functions of plants within the urban ecosystem – with the goal of making Dhaka an ideal city to live in while fighting climate change. The approach of Green Savers is to focus on nature, science and out-of-the-box thinking. The Association encourages the people of Dhaka to improve their understanding and appreciation of nature, and inspires them to become part of the urban socio-ecology by creating rooftop gardens at their homes. Green Savers, which has grown to a vast network with many projects and programmes, provides training, organizes workshops, conducts research and advocates urban agriculture, urban environmental management, and urban community forestry. The Association targets schools, colleges and universities to reach students and teachers, as they are considered to be important agents of change. The Green Savers Association has won several awards and other honours. The Green Savers are part of a wide network and collaborates with various organizations, including Save the Children, ActionAid, Practical Action, and FAO. The Association also works closely with several government bodies, including city corporations, the Forest Department, the Department of Environment, and the Ministry of Education.

What are the Impacts of the Initiative?

The Green Savers Association carries out a wide range of projects and programmes to achieve its broad objectives. The Association, which mainly targets young people in its projects, has implemented a number of initiatives related to agriculture and climate that have had notable impacts. It has established over 3600 rooftop gardens. It has focused its initiatives on schools in the Dhaka area, setting up 380 oxygen banks and establishing over 360 model school gardens. The Association has also started up 100 Green Clubs in schools and colleges; organized 37 Plant-for-the-Planet programmes, and installed three urban lab gardens at schools. It has created at least 24 new job opportunities as ‘plant doctors’ in Dhaka.

Green Clubs and Oxygen Banks

In schools, the Green Savers Association supports environmental education on climate change, climate change adaptation, and disaster risk reduction and management. The Association has set up Green Clubs in schools in cooperation with Save the Children and the Department of Environment in Dhaka. The Green Clubs focus on environmentally friendly technology and promote participatory hands-on activities to encourage children to become involved in sustainable agriculture. The Green Clubs manage ‘oxygen banks’, which allow children to donate a small amount of their lunch money to fund the Green Savers’ roof gardens (Al Amin 2018). The children also carry out regular educational activities with other students using the funds they have collected through the Oxygen Banks.

Environment and Agricultural learning: monthly sessions

The Green Savers Association has set up a knowledge sharing platform called ‘Krishi Patth’. Every month the platform organizes a free learning session about the environment and agriculture for students and parents of different schools, colleges and universities to increase their understanding of urban agricultural technologies.

Plant Doctors for Rooftop Gardens

The Green Savers Association has established positions referred to as ‘plant doctors’ who provide expertise on the management of rooftop gardens. By creating opportunities to pursue a career in urban agriculture, the Association has supported the empowerment of young people who have an educational background in agriculture, and who currently face limited employment opportunities.

Source: *FAO 2019*

Exercises

Exercise 1

1. Acting as a Multiplier

   1. What is your current role in your institution?
   2. How do you perceive your roles as a multiplier?
   3. What are the major capacities for being an effective multiplier?
   4. What are the challenges that a multiplier faces?

Final output should be like this

Source: *GIZ. 2013. Integrating climate change adaptation into development planning. A practice oriented training based on an OECD Policy Guidance. Germany: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).*

Exercise 2

1. Case Analysis

Identify factors that contributed to successful scaling up.
Divide the participants into four groups (may use counting technique - 1,2,3,4..........1,2,3,4....)
Assign each group to work on one case. Let them read, reflect, discuss.
Group I: CA in Zambia
Group II: SRI in Vietnam
Group III: DTMA in Sub-Saharan Africa
Group IV: ACRE in Eastern Africa

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Annexure

Annexure I

Field Visit

Climate Smart Agriculture

- Ask the participants to identify climate smart practices in the area visited.
- Describe each practice and explain why it is climate smart.
- How and to what extent do they contribute to the three pillars of climate smart agriculture?

Barriers

Discuss the factors that hinder the adoption of CSA.
List down socio-cultural, economic, technical, political, and biophysical factors.

Risks

- Identify the risks faced by farmers
- Suggest ways to overcome these risks.

Organizations

- List the organizations working in the agriculture sector in the area.
- Identify the role played/can be played by different organizations in promoting CSA.

Action Plan

- Develop an action plan to promote CSA among farmers.
- The action plan should include all aspects viz., activities, organizations, duration, location, CSA practices, inputs, tools, budget, etc.

Annexure II

Six factors of resilience in adaptation

Resilience is a debated concept, and definitions differ among different writers, yet common to all is the ability to withstand an external disturbance, and the ability to change and sustain this change in the face of an external disturbance, i.e., going beyond survival. Resilience can be seen as synonymous with 'adaptive capacity'; for example defined as 'the ability of a system to adjust to climate change (including variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences', yet there are specific attributes, sometimes referred to as sub-properties of a system, that set firm the importance of focusing on resilience building.

- **Robustness:** refers to the ability of the system to maintain its characteristics and performance in the face of environmental fluctuations or shocks. Within robust systems, reinforcing influences between CBA components help spread the risks and effects of disturbances widely to retain performance. This could include the strengthening of livelihood assets or of the connection between the assets. Examples of climate change specific actions to improve robustness include: investment in strong flood barriers, developing local knowledge management systems with complete data needs, to the selection of crop varieties that are physically able to survive under changing climatic conditions, yet may have lower yields.

- **Scale:** refers to the range of assets and structures a system can access in order to effectively overcome or bounce back from the effects of disturbances. Scale involves, for example, access to networks of support beyond those existent at the immediate community level. From another angle, are adaptation interventions large enough to create a difference, e.g., 10 farmers adapting or 100 farmers adapting their farms to ensure food security in a given area?

- **Redundancy:** refers to the extent to which components within a system can compensate for another in the event of disruption or degradation. Redundancy may also be seen as a collection of processes, capacities and response pathways that allow for partial failure within a system without complete collapse. Collaborative and multi-sector approaches can contribute towards redundancy as they facilitate the existence of overlaps and multiple sources of support and expertise that can help fill the gaps in times of need.

- **Rapidity:** refers to how quickly assets can be accessed or mobilized to achieve goals in an efficient manner. This can be critical particularly when responding to an acute climate-related disturbance. This could be the availability of financial mechanisms, savings, credit or insurance that can be mobilized. Rapid access to information, both incoming and outgoing will also be key to making quick decisions and mobilizing support after hazardous events.

- **Flexibility:** refers to the ability of the system to undertake different sets of actions to make use of opportunities that may arise from change, e.g., a combination of processes, structures or policies that can be utilized to maintain function and direction of a system. This suggests the relevance of flexibility to respond to the challenges at micro, meso and macro levels. Flexibility in the face of climate change can come from various sources, including the existence of social networks that can suggest different courses of action for problem solving.

- **Self-organization:** refers to the ability of the system to independently re-arrange its functions and processes in the face of an external disturbance, without being forced by the influence of other external drivers. Self-organization can be a threefold process based on thinking, communication, and co-operation, brought together to address climate change impacts.

Learning Point

It is difficult to say 'this is resilience building, and that is not'. What is important to understand in the context of rural development and climate change adaptation is that resilience building is the strengthening of linkages and the building of positive and equitable modes of influence between local adaptation assets (financial, human, natural, physical, and political), adaptation strategies/ efforts, and societal structures (levels of government, community, and the private sector) and processes (laws, policies, culture and institutions)(Figure 1).

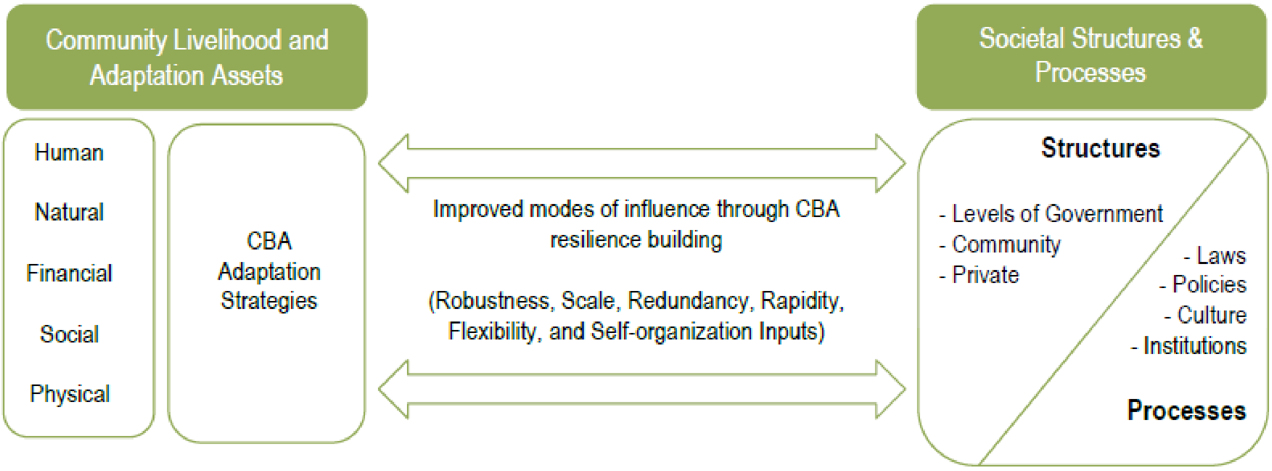

Figure 33: Conceptual framework for CBA adaptation resilience building within a system, community, or society

Source: Solar R. 2014. Building climate resilience: A training manual for community ased climate change adaptation. Regional Climate Change Adaptation Knowledge Platform for Asia, Partner Report Series No. 14. Thailand: Regional Resource Centre for Asia and the Pacific (RRC.AP), Asian Institute of Technology. Available at www.asiapacificadapt.net or www.learninginstitute.org.

Annexure III

Gender refers to socially constructed attributes and opportunities associated with being male and female. It has to do with how society defines masculinity and femininity in terms of what is appropriate behavior for men and women, and both play a crucial role in the social construction of gender.

Gender analysis is the study of the different roles of men and women in order to understand what they do, what resources they have, and what their needs and priorities are. It provides the basis for addressing inequalities in policies, programmes, and projects, and it can be conducted at multiple levels (household, community, and national), across different life stages and in the various roles men and women play.

Gender relations refers to ways in which society defines rights, responsibilities, and identities of men and women in relation to one another, in all spheres of life – in private (family, marriage, and so on) and public domains (schools, labor markets, political life). Other intersecting factors to consider are ethnicity, age, class, religion, and geographic location. Gender relations determine:

- Gender entitlement systems: assets, opportunities, capabilities, and choices;
- Gendered divisions of labour and employment opportunities (such as unpaid and temporary work);
- Gendered patterns of production;
- Power sharing at all levels: decision making, control of resources, and so on.

Gender roles include: (1) **productive** roles that generate an income – women engage in paid work and income generating activities, but gender disparities persist in terms of wage differentials, contractual modalities, and informal work; (2) **reproductive** roles related to social reproduction, such as growing and preparing food for family consumption and caring for children; (3) **community managing** roles that include unpaid and voluntary activities, mainly carried out by women, to complement their reproductive role for the benefit of the community, such as fetching water for the school; and (4) **community or politics** roles related to decision-making processes, such as membership in assemblies and councils. Women's role can be identified as reproductive, productive, and community managing, while men's roles are categorized mainly as either productive, community, or politics. Women's multiple and competing roles lead to their time poverty, which can imply asset and income poverty. The unequal value placed on roles of women compared with men is mainly responsible for their inferior status and the persistent gender discrimination they experience.

Gender equality is when men and women enjoy equal rights, opportunities, and entitlements in civil and political life, in terms of access, control, participation, and treatment.

Gender equity means fairness and impartiality in treating men and women in terms of rights, benefits, obligations, and opportunities. At times, special treatment/affirmative action/positive discrimination is required.

Gender mainstreaming is the process of assessing the implications for men and women of any planned action, including legislation, policies, and programmes, in any area and at all levels. It is a strategy for making the concerns and experiences of women and men an integral part of the design, implementation, monitoring, and evaluation of policies and programmes in all political, economic, and societal spheres, so that they benefit equally, and inequality is not perpetuated. The ultimate goal is to achieve gender equality and gender equity.

Gender-sensitive approaches consider gender as a means to reach a development goal.

Gender-responsive approaches recognize and address the specific needs and priorities of men and women, based on the social construction of gender roles.

Gender-transformative approaches seek to transform gender roles and promote gender-equitable relationships between men and women. The ultimate aim of gender equality is for men and women to have equal participation in decision making; the same access and control over productive resources, services, and technologies; equal benefits from project results; and the same opportunities to access decent employment and livelihood systems.

Source: FAO & World Bank. 2017. Training module: How to integrate gender issues in climate-smart agriculture projects. Rome: Food and Agriculture Organization of the United Nations. (Available at http://www.fao.org/3/a-i6097e.pdf).

Training Module on **Enabling Extension and Advisory Services (EAS) for Climate Smart Agriculture (CSA)**

This Module is intended to assist trainers engaged in capacity development of the agricultural Extension and Advisory Services (EAS) staff on linking farmers to more efficient climate smart agriculture practices/technologies. Climate change has massive impact on the agricultural sector. Climate smart agriculture is designed to overcome the challenges faced by climate change: to sustainably increase agricultural productivity and incomes; adapt and build resilience to climate change; and reduce and/or remove greenhouse gas emissions, where possible. Extension and advisory services need to promote climate smart agriculture approach by integrating wide range of concepts, information and practices from different disciplines and stakeholders. EAS need to create awareness, understanding and relevance of linkages between climate, agriculture and food security.

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