
Welcome

RESEARCH AND EXTENSION IN CLIMATE RESILIENT TECHNOLOGY

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Presented at:

ANNUAL ZONAL WORKSHOP OF KVS

28-30 July, 2023, Aurangabad

“Unless We Act Now” - UNICEF

- Nearly 690 million of the world's 2.3 **billion** children living in areas most exposed to climate change
  - ✓ face higher rates of death, poverty and disease from global warming.
- Almost 530 million children live in countries hardest hit by high floods and tropical storms, **mostly in Asia**.
- An additional 160 million kids are in areas suffering severe droughts, mostly in Africa.

Today's children are the least responsible for climate change, but they, and their children, are the ones who will live with its consequences,"

Huge Concerns…

"It is [therefore] not just island people who are at risk from climate change: 60% of humanity live in coastal areas and therefore share vulnerability to climate change and sea level rise. Low Lying Coastal Areas in all countries are threatened, including agriculturally productive river deltas world wide."

Statement by H.E. T. Neroni Slade
(Samoa on behalf of AOSIS (Alliance of Small Island States)
28 March - 7 April 1995, Berlin, Germany

World Meets in Paris to Save Earth

150 heads of state/govt to attend UN's Paris climate summit inauguration today.

196 nations to negotiate over 11 days, leading to a possible climate deal on Dec 11.

100 countries in Solar alliance, to be launched today by PM Modi & French Prez Francois Hollande.

Date	30 November 2015– 11 December 2015
Location	Paris, France
Also known as	COP 21/CMP 11
Participants	UNFCCC member countries

Objective is to achieve a legally binding and universal agreement on climate, from all the nations of the world.

The overarching goal of the Convention is to reduce greenhouse gas emissions to limit the global temperature increase to 2°C above pre-industrial levels.

The goal to be **"ZERO CARBON, ZERO POVERTY",** and the general secretary Sharan Burrow has repeated that there are **"NO JOBS ON A DEAD PLANET"**..... The International Trade Union Confederation

Budgeted to cost €170m (£122m)

Average Concentration Of CO_2

- It is one of several greenhouse gases in the atmosphere of Earth. The current global average concentration of CO_2 in the atmosphere is (0.04%) **421 ppm as of May 2022**. This is an increase of 50% since the start of the Industrial Revolution, up **from 280 ppm during the 10,000 years prior to the mid-18th century.**
- India become **the world's third-largest emitter of greenhouse gases (GHGs),** after China and the U.S.; in 2021, it emitted **3.9 billion metric tons of carbon dioxide equivalent** ($GtCO_2e$), **accounting for roughly 7% of the global total…..05-May-2023.**
- **India in 2003 had a value of about 370 ppm, which increased to 410 ppm by 2019.**

Climate Change is already a Reality

- Regional variations as well as increased rainfall during summer and reduced number of rainy days can be noticed.
- There is a 0.6° C rise in the last 100 years and it is projected to rise by 3.5-5° C by 2100.
- CO_2 concentration currently is 398.29 ppm (October, 2015) increasing by 1.9 ppm/year and expected to reach 550 ppm by 2050 and 700 ppm by 2100.
- Extreme events like frequency of heat and cold waves, droughts and floods observed in the last decade.
- Sea level rising by 2.5mm/year since 1950.
- The Himalayan glaciers retreating.
- The surface air temperatures will increase by 2 to 4°C by 2070-2100.

❖Only about 35% of total agricultural land in India is irrigated and two thirds of cultivated land entirely dependent on rainfall.

Source: Sustaining Agriculture in the era of Climate Change in India - Civil Society position paper. Centre for Sustainable Agriculture, Jatan Trust and Oxfam India.

Climate Change Projections for India

- an overall increase in temperature by 1–4^{0}C and precipitation by 9–16% towards 2050s.
- different regions are expected to experience differential change in the amount of rainfall in the coming decades.
- The significant aspect of climate change is the increased frequency of occurrence of extreme events such as droughts, floods and cyclones.
- All these expected changes will have adverse impacts on **climate-sensitive sectors such as agriculture, forest and coastal ecosystems, available.**

Some Projections

- Kharif rainfall is going to increase and this might be positive for kharif crops. Further, for *kharif* crops, a one-degree rise in temperature may not have big implications for productivity.
- However, temperature rise in *rab*i season will impact production of wheat, a critical food-grain crop.
- Rabi crop will be impacted seriously and every 1^{o}C increase in temperature reduces wheat production by 4-5 million tons (as per the study by IARI).
  - ✓ This loss can be reduced to 1-2 million tons only if farmers change to timely planting.
- Increased climatic extremes like droughts and floods are likely to increase production variability.
- Productivity of most cereals would decrease due to increase in temperature and decrease in water availability, especially in Indo-Gangetic plains.
- The loss in crop production is projected at 10-40% by 2100, depending upon the modeling technique applied.

Some Projections Contd….

- Apple production is declining in Himachal Pradesh due to inadequate chilling., causing a shift in the growing zone to higher elevations.
- In marine fisheries, Sardines are shifting from the Arabian Sea to the Bay of Bengal, which is not their normal habitat.

- **In fact, fisheries are the most vulnerable sector to climate change.**
- **Crops have the ability to adapt to extreme climate variability even up to, say 4^0C , while fishes and animals do not.**
- **It has also been recorded that the pest ecology of certain crops is changing due to climate change.**

A network of 15 centres of ICAR working on studying climate change.

Evolving definitions of vulnerability

1998	Vulnerability' is the extent to which climate change may damage or harm a system; it is a function of both sensitivity to climate and the ability to adapt to new conditions. (IPCC: Special Assessment Report 1998)
2001	Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. (IPCC: Third Assessment Report 2001)
2007	Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, the sensitivity and adaptive capacity of that system. (IPCC: Fourth Assessment Report 2007)
2012	Vulnerability: The propensity or predisposition to be adversely affected. (Special report of the IPCC 2012)
2014	Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. (IPCC: Fifth Assessment Report 2014)

Types of vulnerability assessment frameworks

1. **Physical or biophysical vulnerability assessment**: “Biophysical vulnerability is often viewed in terms of the amount of damage experienced by a system as a result of an encounter with a hazard” (Jones and Boer 2003).
2. **Social vulnerability assessment:** “Social vulnerability refers to the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard” (Wisner et al. 2004).
3. **Socio-economic vulnerability assessment:** “Socio-economic vulnerability is the endogenous inability of the unit to face shocks. This endogenous inability is a function of risk exposure and other socio-economic factors” (FAO 2003).
4. **Hazard-specific vulnerability:** “A hazard vulnerability assessment (HVA) is a systematic approach to identify all possible hazards that may affect a specific population, assess the risk associated with each hazard (e.g., the probability of hazard occurrence and the consequences for the population),” (Du et al. 2015).
5. **Integrated vulnerability assessment**: Integrated vulnerability assessment is based on biophysical, socioeconomic, institutional, and infrastructure-related vulnerability indicators (DST 2020).

Understanding the vulnerability landscape of India in a changing climate scenario

1. **Exposure is "the presence of people, livelihoods, species or ecosystems, environmental functions, services, resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected" (IPCC 2014).**

2. **Sensitivity is "the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or v ariability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise)" (IPCC 2001).**

3. **Adaptive capacity is "the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (IPCC 2001).**

- **The IPCC acknowledges these three components as key elements of vulnerability**.

Approaches to Analysis of Vulnerability to Climate Change

Three major approaches to analysis of vulnerability to climate change.

1. **Socio-economic Approach:** in terms of education, wealth, health status, access to resources (credit, information, etc.), social capital and so on.
2. **Biophysical Approach:** assesses the level of damage of a given environmental stress on both social and biological systems,
   - Generally identified with impact assessment or hazard-loss relationship.
   - Focuses on the 'end point', in the context of crop production, how crop yields change under conditions that characterize climate variability or climate change.
3. **Integrated Approach:** combines both socio-economic and biophysical approaches.

Weightage for Sensitivity Criteria

S.No.	Sensitivity	Weight(%)
1	Net sown area as % geographical area	15
2	Degraded land as % geographical area	5
3	Annual rainfall (normal)	20
4	Cyclone proneness	5
5	Area prone to flood incidence	10
6	Drought proneness	20
7	A WHC of soil	5
8	Stage of groundwater development	10
9	Rural population density	5
10	Area operated by small and marginal farmers	5

Weightage for Exposure Criteria

S.No.	Exposure	Weight (%)
1	Change in annual rainfall	10
2	Change in June rainfall	5
3	Change in July rainfall	15
4	Change in number of rainy days	5
5	Change in Max T	8
6	Change in Min T	10
7	Change in extreme hot day frequency	5
8	Change in extreme cold day frequency	3
9	Change in frost occurrence	2
10	Change in drought proneness	12
11	Change in incidence of dry spells of >=14 days	5
12	99 percentile rainfall	5
13	Change in number of events with >100mm rainfall in 3 days	5
14	Change in highest rainfall in a single day as % to annual normal	5
15	Change in highest rainfall in 3 consecutive days as % to annual normal	5

Weightage for Adaptive Capacity Criteria

S.No.	Adaptive capacity	Weight (%)
1	Rural Poor (%)	10
2	SC/ST Population (%)	5
3	Workforce in agriculture(%)	5
4	Literacy(%)	5
5	Gender gap	5
6	Markets per 1 lakh holdings	5
7	Paved roads	5
8	Rural electrification(% villages)	5
9	Net irrigated area(%)	20
10	Density of livestock population	8
11	Fertilizer consumption	8
12	Groundwater availability	15
13	Share of agriculture in district domestic product	4

$$\text{Vulnerability (f)} = \frac{\text{Exposure (E)} \times \text{Sensitivity (S)}}{\text{Adaptive Capacity (AC)}}$$

Mapping India's Climate Vulnerability (State Level)

State	Overall Vulnerability Index Score	Rank
Assam	0.616	1
Andhra Pradesh	0.483	2
Maharashtra	0.478	3
Karnataka	0.465	4
Bihar	0.448	5
Manipur	0.424	6
Rajasthan	0.423	7
Arunachal Pradesh	0.408	8
Sikkim	0.370	9
Odisha	0.368	10

Mapping India's Climate Vulnerability (State level) *contd*.

State	Overall Vulnerability Index Score	Rank
Nagaland	0.365	11
Tamil Nadu	0.339	12
Himachal Pradesh	0.329	13
Jammu & Kashmir	0.328	14
NCT Delhi	0.290	15
Gujarat	0.280	16
Uttar Pradesh	0.269	17
West Bengal	0.257	18
Tripura	0.250	19
Kerala	0.226	20

Mapping India's Climate Vulnerability, A District Level Assessment.. Council on Energy, Environment and Water (CEEW), Report October 2021

Southern-zone is the most vulnerable to all three extreme hydro-met disaster

Component of Vulnerability Zone	Flood	Drought	Cyclone
Northern	High	Medium	Low
Southern	High	High	High
Eastern	High	Medium	High
North – Eastern	Medium	Low	Low
Western	Medium	High	Medium
Central	Low	Medium	Low

North-eastern and eastern zones of India are highly exposed to extreme flood events

Component of Vulne-…rabilityZone	Exposure			Sensitivity			Adaptive Capacity
	Flood	Drought	Cyclone	Flood	Drought	Cyclone	
Northern	Medium	Low	Low	High	Medium	Medium	Low
Southern	Medium	High	High	High	High	High	Low
Eastern	High	Medium	High	High	Low	High	Medium
North – Eastern	High	Low	Low	Medium	Low	Low	Low
Western	Low	Low	Medium	Medium	High	High	Low
Central	Medium	High	None	Low	Medium	Low	Low

State of Vulnerability: Top 20 Flood-exposed districts

S. No.	District	Index	S. No.	District	Index
1	Darbhanga	1.000	11	Mumbai	0.842
2	Madhubani	1.000	12	Dibrugarh	0.736
3	Samastipur	1.000	13	Lakhimpur	0.736
4	Nayagarh	0.947	14	Barpeta	0.684
5	Puri	0.947	15	Golaghat	0.684
6	Chennai	0.894	16	Nagaon	0.684
7	West Tripura	0.894	17	Sheohar	0.684
8	Dhemaji	0.842	18	Sitamarhi	0.684
9	Dhubri	0.842	19	West Godavari	0.684
10	Khordha	0.842	20	Darrang	0.631

State of Vulnerability :Top 20 Drought-exposed district

S. No.	District	Index	S. No.	District	Index
1	Rajkot	1.0	11	Bhilwara	0.8
2	Anantapur	0.9	12	Bijapur	0.8
3	Aurangabad	0.9	13	Chittoor	0.8
4	Barmer	0.9	14	Osmanabad	0.8
5	Churu	0.9	15	Rajsamand	0.8
6	Jaisalmer	0.9	16	Udaipur	0.8
7	Jodhpur	0.9	17	Bidar	0.7
8	Nagaur	0.9	18	Gulbarga	0.7
9	Ahmadnagar	0.8	19	Jalgaon	0.7
10	Ajmer	0.8	20	Kolar	0.7

State of Vulnerability :Top 20 highly Cyclone-exposed districts

S. No.	District	Index	S. No.	District	Index
1	Nayagarh	1.000	11	East Godavari	0.611
2	Puri	1.000	12	Srikakulam	0.611
3	Khordha	0.944	13	Krishna	0.555
4	Chennai	0.777	14	Paschim Medinipur	0.501
5	Baleshwar	0.722	15	Guntur	0.444
6	Bhadrak	0.722	16	Imphal East	0.388
7	Cuttack	0.722	17	Jamnagar	0.388
8	Gajapati	0.722	18	North 24 Parganas	0.388
9	Ganjam	0.722	19	West Godavari	0.388
10	Sri Potti Sriramulu Nellore	0.666	20	Jagatsinghpur	0.333

State of Vulnerability: Flood hotspots in India

Zone		District hotspots
Central	7	Bhopal, Tikamgarh, Sagar, Rewa, Balaghat, Chhatarpur, Satna
East	14	Bardhaman, Araria, Purnia, Birbhum, Nadia, Gajapati, Jalpaiguri, Maldah, Paschim Champaran, Gopalganj, Ganjam, Baleshwar, Darjeeling, Purulia
North	11	Ambala, Shimla, Barabanki, Leh (Ladakh), Bahraich, Kulgam, Hardwar, Kinnaur, Kangra, Yamunanagar, Gorakhpur
North-east	13	Imphal East, Kamrup, Dhalai, Lakhimpur, Karbi Anglong, South Garo Hills, Hailakandi, Tinsukia, South Chandel, Thoubal, Dimapur, North Tripura, Dhemaji
South	9	Dakshina Kannada, Mahbubnagar, Kozhikode, Kannur, West Godavari, Uttara Kannada, YSR, Chittoor, Hyderabad
West	14	Jalgaon, Kachchh, Anand, Sabar Kantha, Ratnagiri, Rajkot, Bhavnagar, Banas Kantha, Jamnagar, Aurangabad, Pune, Amravati, Surendranagar, Mumbai
	68	Also drought hotspot

State of Vulnerability : Drought hotspots in India

Zone		District hotspots
Central	8	Sagar, Rewa, Sidhi, Balaghat, Bijapur, Chhatarpur, Dewas, Jhabua
East	13	Gajapati, Ganjam, Baleshwar, Buxar, Khordha, Bhagalpur, Sundargarh, Bhojpur, Sheohar, Saharsa, Begusarai, Arwal, Darbhanga
North	9	Aligarh, Faizabad, Auraiya, Ghaziabad, Budaun, Pilibhit, Azamgarh, Gurgaon, Ambedkar Nagar
North-east	8	Goalpara, Morigaon, Nalbari, Darrang, West Siang, Barpeta, Sivasagar, Cachar
South	17	Dakshina Kannada, Mahbubnagar, Vizianagaram, Kozhikode, Kannur, West Godavari, Uttara Kannada, YSR, Hyderabad, Pathanamthitta, Kasaragod, Malappuram, Thiruvallur, Guntur, Koppal, Gadag, Sri Potti Sriramulu Nellore
West	13	Jalor, Sangli, Jalgaon, Kachchh, Rajkot, Bhavnagar, Banas Kantha, Jamnagar, Aurangabad, Nagpur, Pune, Amravati, Surendranaga

State of Vulnerability :Cyclone hotspots in India

Zone		District hotspots
East	15	Gajapati, Ganjam, Baleshwar, Buxar, Khordha, Bhagalpur, Sundargarh, Bhojpur, North 24 Parganas, Sheohar, Saharsa, Begusarai, Jagatsinghpur, Arwal, Darbhanga
North	2	New Delhi, Jammu
North - east	2	Imphal East, Nagaon
South	14	Dakshina Kannada, North and Middle Andaman, Vizianagaram, Kozhikode, Kannur, West Godavari, Uttara Kannada, YSR, Hyderabad, Malappuram, Thiruvallur, Guntur, Sri Potti Sriramulu Nellore, Thanjavur
West	9	Jalor, Kachchh, Ratnagiri, Rajkot, Bhavnagar, Jamnagar, Mumbai, Porbandar, Navsari
	42	Also flood and drought hot spots

20 Most Vulnerable districts of India

Rank	District	Events	Exposure	Sensitivity	Adaptive Capacity	Vulnerability Index
1	Dhemaji	Flood	0.980	0.900	0.350	1.000
1	Khamman	Flood & Drought	0.450	0.740	0.140	1.000
1	Gajapati	Flood &Cyclone	0.875	0.960	0.360	1.000
1	Vizianagarm	Drought & Cyclone	0.909	1.000	0.400	1.000
1	Sangli	Drought	0.820	1.000	0.470	1.000
1	Nagaon	Flood, Drought & Cyclone	0.830	0.890	0.470	1.000
2	Chennai	Flood &Cyclone	1.000	0.690	0.450	0.976
3	Madhepura	Flood & Drought	0.860	0.750	0.290	0.935
3	Imphal East	Flood &Cyclone	0.720	1.000	0.490	0.935
4	Sitamarhi	Flood & Drought	0.970	0.710	0.310	0.934

20 Most Vulnerable districts of India *contd.*

Rank	District	Events	Exposure	Sensitivity	Adaptive Capacity	Vulnera bility Index
4	Banka	Flood & Cyclone	0.610	0.770	0.320	0.934
5	Jaisalmer	Drought	0.990	0.690	0.420	0.932
6	Pashchim Champaran	Flood	0.810	0.950	0.330	0.925
7	Darbhanga	Flood, Drought & Cyclone	0.925	0.810	0.350	0.917
8	Khagaria	Flood	0.780	0.990	0.310	0.910
9	Araria	Flood	0.700	0.980	0.300	0.907
10	Lakhimpur	Flood	0.950	0.870	0.410	0.869
11	Jodhpur	Drought	0.990	0.730	0.480	0.863
12	Jalor	Drought & Cyclone	0.818	1.000	0.420	0.857
13	Darrang	Flood & Drought	0.960	0.800	0.380	0.850

Very High and High Vulnerable districts of Maharashtra.

Rank	District	Events	Exposure	Sensitivity	Adaptive Capacity	Vulnerability Index
1	Sangli	Drought	0.820	1.000	0.470	1.000 VH
15	Ahmadnagar	Drought	0.960	0.650	0.440	0.813 VH
22	Solapur	Drought	0.820	0.750	0.470	0.733 VH
27	Dhule	Drought	0.820	0.750	0.480	0.734 VH
28	Mumbai	Flood & Cyclone	0.940	0.760	0.620	0.733 VH
37	Buldana	Drought	0.820	0.650	0.440	0.694 VH
49	Hingoli	Drought	0.760	0.520	0.370	0.612 VH
49	Jalgaon	Flood & Drought	0.630	0.970	0.420	0.612 VH
52	Osmanabad	Drought	0.960	0.550	0.510	0.593 H
59	Parbhani	Drought	820	430	0.360	0.561 H

Very High and High Vulnerable districts of Maharashtra.

Rank	District	Events	Exposure	Sensitivity	Adaptive Capacity	Vulnerability Index
61	Nandurbar	Drought	0.760	0.550	0.430	0.557 H
61	Nagpur	Drought	0.680	0.800	0.560	0.557 H
68	Satara	Drought	0.820	0.650	0.570	0.536 H
74	Akola	Drought	0.680	0.700	0.520	0.525 H
79	Nanded	Droight	0.760	0.460	0.500	0.401 H
82	BId	Drought	0.820	0.580	0.550	0.496 H
87	Aurangabad	Flood & Drought	0.740	0.810	0.520	0.485 H

High Vulnerable districts of Gujarat..

Rank	District	Events	Exposure	Sensitivity	Adaptive Capacity	Vulnerability Index
54	**Surendranagar**	**Flood & Drought**	**0.860**	**0.780**	**0.490**	**0.576 H**
66	**Ahmedabad**	**Flood & Drought**	**0.930**	**0.750**	**0.540**	**0.543 H**
103	**Rajkot**	Flood, Drought & Cyclone	**0.625**	**0.880**	**0.540**	0.437 H

Climate Change Adaptation – India Policy Initiatives

- India has already started development and inclusion of climate change adaptation polices in various sectors.
- The National Action Plan on Climate Change (NAPCC) of India identifies eight core missions that promote various climate smart interventions in agriculture and allied sectors.
  - For example, National Missions for Sustainable Agriculture (NMSA) and National Mission on Strategic Knowledge for Climate Change (NMSCC) aiming at supporting climate change adaptation in agriculture through promotion of climate-smart practices and technologies across the country.
- State-level climate change adaptation plans in India focus on addressing the existing, as well as future, challenges of climate change and take actions to reduce the associated risks and vulnerabilities.

Climate Change Agriculture and Food Security (CCAFS) in India

- CCAFS's major activities in India include test, evaluate and develop portfolios of climate-smart interventions for different agro-ecological zones and farm types;
  - promotion of Climate Smart Agriculture (CSA) through the **Climate-Smart Village (CSV) approach;**
  - weather-based insurance; use of ICT for dissemination of climate information based agro-advisories;
  - mapping hotspots of germplasm collection and conservation;
  - crowdsourcing farmers preferences for stress resistant varieties;
  - gender and social inclusion in climate change adaptation; and
  - development of decision-support tools for planning and investment in adaptation and mitigation activities.
- CCAFS and CGIAR centers together are engaging with national and sub-national stakeholders including policymakers, NGOs and civil society groups, research organizations, farmers groups and private sector
- Priority areas include Indo-Gangetic Plan of Northern India and dryland agriculture systems in southern and western parts of India.

Mainstreaming Community-Based Adaptation Into Agricultural Programmes

Based on experiences in Bangladesh, Uganda, India and Mozambique

- A supportive enabling environment with participation of local communities to integrate adaptation into development.
- Scaling up means more than **just physical scaling up** (mass replication); **but also social scaling up** (increasing social inclusiveness) and **conceptual scaling up in terms of moving beyond participation to embedding empowerment in the entire development process**
- **Climate Smart Agriculture** (CSA) refers to:
  - ✓ agricultural practices and systems that sustainably increase productivity and resilience (adaptation),
  - ✓ reduce or remove greenhouse gases (mitigation), and
  - ✓ enhance achievement of national food security and development goals.

Ensuring Community-based Adaptation of Agricultural Technology

Key roles of extension services and farmers.

- Emphasis on organizations as mechanisms for linking between national-level and community-level adaptation, and associated range of activities
- success factors include participative and locally driven vulnerability assessments and tailoring of adaptation
- Selection of technologies to local contexts, mapping local institutions and working in partnership across institutions.

Climate-Smart Village Activities

Weather Smart

- Weather forecasts
- ICT-based agro-advisories
- Index-based insurance
- Climate analogues

Water Smart

- Aquifer recharge
- Rainwater harvesting
- Community management of water
- Laser-leveling
- On-farm water management

Carbon Smart

- Agroforestry
- Conservation tillage
- Land-use systems
- Livestock management

Nitrogen Smart

- Site-specific nutrient management
- Precision fertilizers
- Catch-cropping/ legumes

Energy Smart

- Biofuels
- Fuel-efficient engines
- Residue management
- Minimum tillage

Knowledge Smart

- Farmer-to-farmer learning
- Community seed and fodder banks
- Market information
- Off-farm risk management

Climate-Smart Technologies Adopted and Disseminated, and their Monetary Advantages (Karnal Dist. ,Haryana)

	Technologies adapted and disseminated	Climate-smart category	Yield gains over local farmers' practices (kg ha^{-1})	Monetary gains over local farmers' practices (US$ ha^{-1})	No. of farmers benefited
1	Laser land levelling	Water smart	480	144	250
2	No-till wheat with residue retention (turbo seeder)	Carbon, energy and water smart	600	174	60
3	Direct dry seeded rice	Water and energy smart	00	180	60
4	Site-specific INM Nutrient decision support tool in rice-wheat system	Nutrient smart	550	127	82

(Karnal dist., Haryana) contd….

	Technologies adapted and disseminated	Climate-smart category	Yield gains over local farmers' practices (kg ha^{-1})	Monetary gains over local farmers' practices (US$ ha^{-1})	Number of farmers who benefited
5	GreenSeeker sensor guided nitrogen application	Nutrient smart	275	72	10
A	Relay mungbean in wheat	Carbon smart	855	217	5
B	Dual purpose wheat		1230	313	5
C	Introduction of maize replacing rice	Water smart	a	315	2

Case Study-2

Mainstreaming of CBA in Agriculture in Bangladesh

'Livelihood Adaptation to Climate Change' (LACC) project

- Located in the low-lying Ganges–Brahmaputra delta.
- Bangladesh is at risk of increasing flooding, more intense cyclones and sea level rise in a warmer climate.
- The project promoted livelihood adaptation among vulnerable communities, implemented jointly by the Department of Agricultural Extension (DAE) and Food and Agriculture Organisation (FAO).
- The project assessed existing locally specific risk-coping strategies and technologies, monitored local agro-meteorological data and downscaled climate scenarios, intending to create an overlap between local and scientific knowledge.
- Adaptation needs to be highlighted as a social learning process, and inclusive and participatory mechanisms can contribute to this learning.

CBA: Community Based Adaptation

Bangaladesh contd.

- **General lessons learnt:**
  - ✓ Integration of disaster risk reduction (DRR)
  - ✓ Adaptation into operational local-level frameworks are crucial to initiate long-term processes,
  - ✓ There is no need to set up separate institutional structures within sectoral line agencies,
  - ✓ Adaptation needs to be highlighted as a social learning.

Adapting to Climate Change in Semi-arid Environments in Mozambique

Case Study-3

- Major challenges include the capacity of farmers' organizations and extension services, farmers' access to markets and coordination across implementing agencies, particularly at local levels.
- UN Joint Program (UNJP) on Environmental Mainstreaming and Adaptation to Climate Change, which aimed to help Mozambique integrate climate change into national policy and set up pilot adaptation projects.
- Pilot projects were implemented in Chicualacuala, Gaza Province.
- Prioritizes early warning systems, increasing producer capacity and management of water resources
- UNJP assisted the government by rehabilitating and re-equipping a weather station and station.
- In an area where livestock is crucial to livelihoods, a network of trained Community Animal Health Workers (CAHW) was established.
- Taking actions at the community level meant problems could be identified more accurately and locally appropriate preventive measures could be taken.

Climate-Smart Adaptation Research in Rakai District, Uganda

Case Study-4

- Climate change threatens to decrease yields, reduce farm revenues, worsen food insecurity and deepening rural poverty
- Participatory research was undertaken by the International Institute of Tropical Agriculture (IITA) with producers in assessment of vulnerability and evaluation of adaptation options, as part of the Climate Change Agriculture and Food Security (CCAFS) research programme.
- Smallholder farmers took centre stage in developing 'climate-smart' options on the premise that effective participation of vulnerable communities is likely to enhance design, adoption and ownership of adaptation.

Diversification : A Key Measure

Type of Diversification	Nature of Diversification	Benefit	Examples
Increased Structural Diversity	Makes crops within the field more structurally diverse	Pest suppression	Strip-cutting alfalfa during harvest allows natural enemies to emigrate from harvested strips to adjacent non harvested ones (Hossain et al. 2001)
Genetic diversity in Monoculture	Growing mixed varieties of a species in a Monoculture	Disease Suppression	Genetic diversity of rice varieties reduces fungal blast occurrence(Zhu et al. 2000)

Diversification : A Key Measure Contd..

Type of Diversification	Nature of Diversification	Benefit	Examples
Diversify field with non crop vegetation	Growing weed strips or vegetation banks in and alongside crops	Increased production stability	Increased genetic diversity was positively related to mear income and stability of income(Di Falco and Perrings 2003)
		Pest suppression	Grassland or refugia planted at field margins(beetle banks)were used as overwintering habitat for natural enemies(Thomas et al. 1991)
		Pest suppression	Using white and black mustard on the field of margins of sweet corn crop s trapped pests and prevented them from entering the corn field.(Rea et al.2002)
	Temporal diversity through crop rotations	Disease Suppressions	Alternating cereal crops with broad leaf crops and changing stand densities disrupt the disease cycles(Krupnsky et al 2002)
		Increased Production	Manipulating diversity through crop rotations of greater cover crop and nitrogen fixing crops increased the

Diversification : A Key Measure Contd..

Type of Diversification	Nature of Diversification	Benefit	Examples
Polycultures	Growing two or more crop species and wild varieties within the field spatial and temporal diversity of crops.	Disease Suppression Climate change buffering Increased Production Increased production	Grassland field planted with multiple species to decrease disease transmission(Mitchell et al.2002) More ecologically complex systems with wild varieties at temporal and spatial diversity of crops were able to grow under climate stress (Tengo and Belfrage2004) Grassland plots with greater in-field species diversity led to more stable feed and fodder production.(Tilman et al.2006) Grassland plots with greater in-field species diversity led to more stable feed and fodder production.(Picasso et al 2008)

Diversification : A Key Measure Contd..

Type of Diversification	Nature of Diversification	Benefit	Examples
Agroforestry	Growing crops and trees together; spatial and temporal diversity	Pest Suppression Pest Suppression Pest Suppression	Willow trees grown in natural willow habitats experience lower rates of pest outbreak of the leaf beetle(Dalin et al 2009) Greater shade diversity increased bird natural enemy abundance for larval control on crop plant.(Perfecto et al.2004) Coffee berry borer control increased with greater ant diversity and abundance in shade systems.(Armbrecht a Gallego 2007)

Current Projects on Climate Change Adaptation

1	**ICARDA: Middle East Water and Livelihoods Initiative (WLI)**	**Middle East: Egypt, Iraq, Jordan, Lebanon, Palestine, Syria, Tunisia, & Yemen**
2	**CGIAR CRP Climate Change, Agriculture and Food Security (CCAFS) Project at the University of Florida -Gender and participatory action research**	**East and West Africa and South Asia.**
3	**Modernizing Extension and Advisory Services (MEAS): Extension and Advisory Service Delivery for Women's Groups in Jordan: Assessing Competencies and Building Social Capital**	**Jordan's National Center for Agricultural Research and Extension (NCARE) Socio-Economic Division**
4	**Further Advancing the Blue Revolution Initiative - to improve agricultural water management, foster trans-boundary water cooperation and improve water and sanitation utility performance and financial viability.**	**USAID/DAI project**

Current Projects on Climate Change Adaptation Contd….

4	Gender and climate change in wheat-based systems in Morocco	USAID-funded Climate Change CRP (CRP7) Project
5	Innovate: Innovation for Agricultural Education and Training	To develop the human and institutional capacity necessary for developing countries to promote rural innovation needed to achieve sustainable food security, reduce poverty, conserve natural resources and address other rural problems

CRP7: CGIAR Research Program on Climate Change

Current Projects on Climate Change Adaptation Contd…

6	Climate Change Adaptation – North Eastern Region of India (CCA-NER)	• German Federal Ministry for Economic Cooperation and Development (BMZ) • Country : India • Lead executing agency: Ministry of Development of North Eastern Region (MoDoNER), Government of India • The regional project partners are the State Planning Department in Meghalaya, the Nagaland Empowerment of People through Economic Development and the Department of Science, Technology and Climate Change in Sikkim.

Participatory Research and Capacity Building: Climate Resilience and Seeds in Zimbabwe

According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) "**What's in it for Africa?"**

- Africa's climate is changing and the impacts are already being felt.
- Southern Africa has experienced an increase in annual average, maximum and minimum temperatures
- In some districts of Zimbabwe, the rainy days have reduced from 32 days to 28 days in a span of two years.
- The impact of this will be largely felt in the agricultural sector where climate change is likely to affect agricultural output leading to food insecurity and loss of livelihoods for rural farmers.

Zimbabwe Contd.

- Biodiversity International, in collaboration with the Community Technology Development Trust of Zimbabwe (CTDT), organized a training workshop, in Harare, 11-15 May 2015
  - Resilience seed systems and adaptation to climate change
  - Bringing together more than 20 scientists, breeders, GIS specialists, climate change specialists and extension workers.
- At the workshop, participants learned
  - GIS and climate modelling techniques to identify climate challenges in selected communities in the Uzumba-Maranga–Pfumbwe (UMP) and Tsholotsho districts in Zimbabwe
  - Further identify germplasm that could be used in the future.
  - Participants also visited a community seedbank in UMP and conducted participatory exercises to identify climate challenges;
  - To assess local diversity within the community and determine whether these meet their needs; and
  - To identify traits that they need for present and future climate change adaptation.

Zimbabwe Contd.

- Results from the exercises reveal that these communities are facing increased minimum and maximum temperatures and shorter rainy days.
- An analysis of 2050 climate using one climate model – DIVA-GIS crop suitability modelling – also reveals that mean, minimum and maximum temperatures will increase and although rainfall will increase slightly, it is likely to be more erratic with shorter rainy days.
- Farmers identified the following traits, in order of importance as a variety being bred for future climates:
  - early maturing;
  - high yielding and
  - resistant to pests and diseases.
- By looking at accessions from national genebanks and international sources such as GENESYS (Global Portal to Information about Plant Genetic Resources for Food and Agriculture), the group identified accessions of finger millet, sorghum and pearl millet which will now be tested with farmers.
- One of the longer term adaptation strategies is to identify germplasm that is suited and adaptable to the changing climate both at present and in the future.

Component of Climate Change Adaptation – North Eastern Region of India (CCA-NER)

Applies a range of human, institutional and societal capacity development measures:

- Preparation and assistance in implementing State Action Plans on Climate Change
  - ✓ Drafting of a water policy in Meghalaya
  - ✓ Spring-shed development and the preparation of village water security plans in Tendong Hill region, Sikkim
  - ✓ Support for the cultivation of indigenous rice varieties in Meghalaya and Nagaland

Component of Climate Change Adaptation – North Eastern Region of India (CCA-NER) Contd…

- Improvement of Eri Silk production in Meghalaya
- A study on the regeneration, conservation and sustainable management of oak forests in Sikkim
- Inputs for the integrated management of land and water resources in the Upper Umiam River Basin, Meghalaya
- Breeding of indigenous fish species in Meghalaya
- Support for the compilation of climate change relevant data in Meghalaya
- Training and awareness raising on climate change, at government and community levels

Indicators of Target Sectors for the Project

AGGREGATED INDICATORS FOR THE ADAPTIVE CAPACITY OF TARGET GROUPS:

1. income of target groups shall increase,
2. percentage of population below poverty line in programme villages shall decrease,
3. sources of income for vulnerable communities/households shall diversify.

SPECIFIC SECTORAL INDICATORS:

1. increase of agricultural productivity,
2. increase of water availability,
3. improved forest/vegetation cover,
4. reduced damage due to floods (damage costs, reduced flooded agricultural area).

Climate Change Study Tools

- ✓ Tool 1. Village resources map
- ✓ Tool 2. Seasonal calendar
- ✓ Tool 3. Daily activity clocks
- ✓ Tool 4. Farming systems diagram
- ✓ Tool 5. Capacity and vulnerability analysis matrix
- ✓ Tool 6. Venn diagram
- ✓ Tool 7. Institutional profiles
- ✓ Tool 8. Changing farming practices
- ✓ Tool 9. Seasonal food security calendar
- ✓ Tool 10. Climate-related risk management practices

Climate Analogues Tools

- Tool 1. Village resources map
- Tool 2. Seasonal calendar
- Tool 3. Daily activity clocks
- Tool 4. Farming systems diagram

Weather Forecast Tool

- Tool 9. Seasonal food security calendar

Tools for Understanding and Catalyzing Gender-sensitive Climate-Smart Agriculture Initiatives

- Tool 6. Venn diagram
- Tool 7. Institutional profiles
- Tool 8. Changing farming practices

Village Resources Map

- Infrastructure (roads, houses, buildings)
- Water sites and sources (drinking water, water bodies, irrigation sources, rivers, plus entitlement and utilization)
- Agricultural lands (crop varieties and location)
- Agro-ecological zones (soils, slopes, elevations)
- Forest lands
- Grazing areas
- Shops, markets, small industries
- Health clinics, schools and religious facilities
- Waste sites and
- Special use places (bus stops, cemeteries, shrines)
- A variation of this tool is: resources map of past and present

Report on Building Environment Resilience

Key recommendations:

- Donors, governments and international organisations should increase overall financial, research, and technical support to ecological farming
- County and national governments should increase investment in policies that promote ecological farming, particularly for small scale farmers.
- Private companies and public institutions need to link up with small-scale farmer associations to supply ecologically grown produce
- Better monitoring and assessment of resilience-building initiatives
- Farmer participation: Projects should ensure participation of relevant communities especially small-scale farmers and women.
- More coordinated policy making ensuring synergy with the various development goals.
- Use of farmer field schools. For example, government can integrate these into its agricultural policy extension programmes.

Source: Thompson K, Kruszewska I, Tirado R. 2015. Building environmental resilience: A snapshot of farmers adapting to climate change in Kenya. Greenpeace Research Laboratories Technical Report: 04-2015.

Support of European Union for Development of Innovative Participatory Approaches

- Conditions—the EU might support the development of innovative participatory approaches for the management of agricultural biodiversity in Europe. In particular:
  - ✓ transforming knowledge and ways of knowing for the local adaptive management of agricultural biodiversity and resilience in the face of climate change and uncertainty;
  - ✓ scaling up and institutionalizing participatory research and innovation in plant breeding, varietal selection, and agroecological research; and
  - ✓ policy reversals for the participatory management of agricultural biodiversity.
- The construction of a new modernity for food and farming in Europe also depends on such a transformation.

Source: Michel Pimbert Foreword by Colin Tudge; Book/Report, 80 pages

Summary

The interventions cover the following four modules:

Module I : Natural resources

- This module consists of interventions related to in-situ moisture conservation, water harvesting and recycling for supplemental irrigation, improved drainage in flood prone areas, conservation tillage where appropriate, artificial ground water recharge and water saving irrigation methods.

Module II : Crop Production

- This module consists of introducing drought/temperature tolerant varieties, advancement of planting dates of rabi crops in areas with terminal heat stress, water saving paddy cultivation methods (SRI, aerobic, direct seeding), frost management in horticulture through fumigation, community nurseries for delayed monsoon, custom hiring centres for timely planting, location specific intercropping systems with high sustainable yield index.

Summary *contd*

Module III : Livestock and Fisheries

- Use of community lands for fodder production during droughts/floods, improved fodder/feed storage methods, preventive vaccination, improved shelters for reducing heat stress in livestock, management of fish ponds/tanks during water scarcity and excess water, etc.

Module IV : Institutional Interventions

- This module consists of institutional interventions either by strengthening the existing ones or initiating new ones relating to seed bank, fodder bank, commodity groups, custom hiring centre, collective marketing, introduction of weather index based insurance and climate literacy through a village level weather station.

https://en.wikipedia.org/wiki/National_Initiative_on_Climate_Resilient_Agriculture

To Conclude…

- Climate-smart solutions will only be effective if there is political will among national and local leaders to address constraints jointly.
- Building relevant capacities of different stakeholders, specifying roles for different actors and securing commitment from them to deliver on roles.
- Identifying the right stakeholders for institutional support.

"The Maldives is one of the small states. We are not in a position to change the course of events in the world. But what you do or do not do here will greatly influence the fate of my people. It can also change the course of world history."

Statement by H.E. Maumoon Abdul Gayoom (Maldives)

4 December 1997, Kyoto, Japan (COP 3)


Thank You