India's Experience on Climate Resilient Villages

G20 MACS, Japan

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Climate change is happening and the globe is warmer by 0.85 [0.65 to 1.06] °C over the period 1880 to 2012.

Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate.

Warming greater than the global average is being experienced in many land regions and seasons including 2 to 3 times higher in the Arctic.

Source: IPCC 2018; IPCC 2013
Evidences of climate change

The number of cold days and nights has decreased and the number of warm days and nights has increased globally.

Frequency of heat waves has increased in large parts of Europe, Asia and Australia.

The Greenland and Antarctic ice sheets have been losing mass.

Glaciers have continued to shrink globally.

Global sea level rose by 0.19 m between 1901 and 2010.

An increase in frequency of extreme events have been observed since 1950.

Negative impacts of climate change on crops are more common and coupled with rising population would pose large risks to food security globally.

Source: IPCC 2013
Rainfall variability, frequency of *El Nino* and droughts is increasing.

No. of years experienced drought 1870-1939: 10 whereas during 1940-2010: 15.
Extreme Events in the recent past (India)
## Impact of Climate Change on Agriculture in India

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Projected Impact</th>
</tr>
</thead>
</table>
| Rice               | Irrigated rice yield to reduce by 4% in 2020 (2010-2039)  
                    | Rainfed rice yield to reduce by 6% in 2020 (2010-2039)  
                    |                                                                                                                                                      |
| Wheat              | 1°C rise in temp reduce yield by 6 mt  
                    | Yield reduction (6-23%) by 2050.                                                                                                                     |
| Apple              | Lack of sufficient chilling hours, extreme weather events, poor pollination, shifting of apple cultivation from low to high altitude (up to 30% yield reduction)                                   |
| Cattle & Buffalo   | Estimated yield loss in milk due to heat stress at 1.8 m.t/ year, which is about 2 %of the total production in the country  
                    | ▪ Decline in availability of water may further effect animal productivity                                                                         |
| Marine Fisheries   | Sea surface temperature has increased by 0.2 to 0.3°C along the Indian coast in the last 45 years, and is projected to increase by 2.0 to 3.5°C by 2099  
                    | ▪ Latitudinal extension in abundance, spawning, breeding activity of several species to be affected                                               |
Objectives

▪ To undertake strategic research on adaptation and mitigation
▪ To validate and demonstrate climate resilient technologies on farmers' fields
▪ To strengthen the capacity of scientists and other stakeholders in climate resilient agriculture
▪ To draw policy guidelines for wider scale adoption of resilience-enhancing technologies and options

Challenge

▪ To enhance the resilience of Indian agriculture to climatic variability and climate change
Unique project brings all sectors of agriculture viz., crops, horticulture, livestock, fisheries, NRM and extension scientists on one platform.
Technology Demonstration Component of NICRA

Objectives

- To **demonstrate site specific technology** interventions on farmers fields for coping with **climate variability** in vulnerable districts.
- To generate **awareness and build capacity of farmers** and other stakeholders on climate resilient agriculture.
- To evolve **innovative institutional mechanisms** at village level that enable the communities to respond to climate stresses.

While achieving the above objectives, **Climate Resilient Village approach was evolved**.
Screening Agro-biodiversity for Climate Resilience

<table>
<thead>
<tr>
<th>Region (Climatic condition)</th>
<th>Crop</th>
<th>Varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid &amp; high hills (Delayed rains)</td>
<td>Buckwheat</td>
<td>VL-7, Himgiri</td>
</tr>
<tr>
<td>Mid &amp; high hills (Low rain fall)</td>
<td>Grain amaranth</td>
<td>Annapurna, Durga, PRA-1, PRA-2, VL Chua 44</td>
</tr>
<tr>
<td>Mid &amp; high hills (Mixed crops in apple orchards)</td>
<td>Chenopodium</td>
<td>Him Bhathua</td>
</tr>
<tr>
<td>Mid &amp; lower hills (Sub humid/humid)</td>
<td>Rice bean</td>
<td>PRR-1, PRR-2, VRB-3 and BRS-1</td>
</tr>
<tr>
<td>Mid &amp; lower hills – NEH (Humid)</td>
<td>Perilla</td>
<td>Shillong local and Jayantia local</td>
</tr>
<tr>
<td>Mid &amp; lower hills – NEH, Marshy land (Humid)</td>
<td>Job’s tear</td>
<td>Mayun, Pollin</td>
</tr>
<tr>
<td>Northern plains (Arid/Semi Arid)</td>
<td>Tumba</td>
<td>Mansha Marudhara,</td>
</tr>
<tr>
<td>Northern plains (Arid/Semi Arid)</td>
<td>Kalingda</td>
<td>Gujarat Karingada-1</td>
</tr>
<tr>
<td>Peninsular (Arid/Semi Arid)</td>
<td>Grain amaranth</td>
<td>Kapilasa, Suvarna</td>
</tr>
<tr>
<td>Plains, NEH, Western &amp; Eastern Ghats (Sub humid/humid)</td>
<td>Winged bean</td>
<td>AKWB-1</td>
</tr>
</tbody>
</table>

316 wheat accessions for terminal heat stress tolerance

Promising bread wheat accessions for THST

- IC536050
- IC401940
- EC576585
- IC252619
Developing Multiple Stress Tolerance for Climate Resilience and Sustainability

- Molecular Breeding
- Climate Smart Varieties
  - Productivity
  - Livelihoods

Marker-assisted backcross breeding

Genetic Yield Potential Enhancement
District Agriculture Contingency Plans
(623 of 651 completed)

NICRA/CRIDA/AICRPDA Research outputs & Agri. Universities/KVKs

Updating of contingency plans with Universities/KVKs

NMSA

Implementation of DCPs

District (with State Government authorities)

Taluq/Mandal (AICRPDA/AICRPAM network)

Villages (through KVKs under NICRA-TDC)

Handholding the State Departments for Climate Resilience
Custom Hiring Centers – Spread of the Concept
(5 states considering adopting the model under state funding)

Custom Hiring Centres for Farm Implements

Zone-wise Revenue Generation through Custom Hiring Centers

<table>
<thead>
<tr>
<th>Zone</th>
<th>Highest earning</th>
<th>NICRA-KVK (No.)</th>
<th>Revenue (Rs.)</th>
<th>Average (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Faridkot</td>
<td>12</td>
<td>92,995/-</td>
<td>7,749/-</td>
</tr>
<tr>
<td>II</td>
<td>Saran</td>
<td>15</td>
<td>1,41,735/-</td>
<td>9,449/-</td>
</tr>
<tr>
<td>III</td>
<td>East Tripura</td>
<td>17</td>
<td>1,12,566/-</td>
<td>6,621/-</td>
</tr>
<tr>
<td>IV</td>
<td>Kushinagar</td>
<td>13</td>
<td>18,651/-</td>
<td>1,434/-</td>
</tr>
<tr>
<td>V</td>
<td>West Godavari</td>
<td>13</td>
<td>1,96,030/-</td>
<td>15,079/-</td>
</tr>
<tr>
<td>VI</td>
<td>Kutch</td>
<td>7</td>
<td>3,94,968/-</td>
<td>56,424/-</td>
</tr>
<tr>
<td>VII</td>
<td>Kendrapara</td>
<td>14</td>
<td>94,476/-</td>
<td>6,748/-</td>
</tr>
<tr>
<td>VIII</td>
<td>Namakkal</td>
<td>9</td>
<td>2,27,898/-</td>
<td>25,322/-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>12,79,319/-</strong></td>
<td><strong>12,793/-</strong></td>
<td></td>
</tr>
</tbody>
</table>
Climate Change and Agriculture Knowledge Portal

- Historical Info
- Agromet Advisory
- Contingency Strategies
- Forecasting tools
- Adaptation mitigation strategies
- Agri-Science Tube
- Knowledge Resources
- Form/Group Discussions
Climate Resilient Villages

151 Climate Resilient Villages Established

Modules & Major Interventions in Climate Resilient Village
Selection of CRVs

Vulnerability Atlas has been prepared and vulnerable districts were selected

State-wise distribution of districts with different levels of vulnerability

About 229 districts were found to be high to very highly vulnerable to climate change
Process of Establishing Climate Resilient Villages

1. Selection of Vulnerable District (Vulnerability atlas)
2. Selection of Vulnerable Village/ Block
3. Base line survey
4. Problem Identification
5. Prioritisation of Problems
6. Technological Options
7. Budget Estimates
8. Implementation Plan
9. Establishment of Village Level Institutions
10. Convergence with ongoing schemes
11. Project Implementation
12. Capacity Building
13. Impact studies

Stakeholders:
- ICAR Institutes
- State Agril Universities
- KVKs/NGOs
- Line Departments
- Farmer representatives
Technological & Institutional Options for Climate Resilient Village

**Weather**
1. Village weather stations
2. Automatic weather stations
3. Weather based agro-advisory
4. Documention of aberrant weather conditions
5. Awareness building through extension
6. Real time measures adverse weather

**Water**
1. Aquifer recharge
2. Ground water recharge
3. In-situ moisture conservation
4. Farm ponds
5. Efficient application system
6. Drainage
7. Integrated farming system
8. Flood diversions
9. Community management of water

**Crop**
1. Drought tolerant varieties
2. Flood tolerant varieties
3. Saline tolerant varieties
4. Intercrop/systems
5. Efficient rice systems

**Nutrient**
1. Soil health cards
2. SSNM
3. Legumes
4. INM
5. Precision application
6. Fertigation

**Carbon**
1. Village organic resource inventory
2. Residue recycling
3. Conservation agriculture
4. Tank silt
5. Agro forestry
6. Livestock management

**Institutional**
1. VCRMC
2. Custom Hiring Centers
3. Seed bank and fodder bank
4. Commodity groups
5. Capacity building
Dealing with Drought

Preparedness and real time response measures

- In-situ conservation
- Water harvesting and efficient use
- Life saving irrigation
- Drought escaping cultivars
- Intercropping systems
- Soil health and organic matter and Soil health cards
- Strengthening Farming systems
Resilience Indicators in NICRA Villages

Farm and farmer level (outcome based measure)

Resilience 1: Proportion of normal yield = Yield obtained in stress/normal yield

Resilience 2: Proportion of yield loss avoided

\[
[1 - \frac{(\text{normal yield} - \text{yield with adaptation})}{\text{normal yield} - \text{yield with no adaptation}}]
\]

A more diverse cropping pattern is associated with less decline in farm income (more income resilience), on both per ha and per household basis.

Village level (process based measure)

Process or Institutional indicators

A ratio of closer to 1 indicates better resilience and a ratio of more than 1 implies it is a potential case for general recommendation irrespective of the occurrence of climatic stress.

During a drought year, different adaptation interventions gave a yield closer to the “normal yield” compared to “no adaptation”; IMC = In-situ moisture conservation.

NICRA village did better with respect to indicators related to technology adoption and showed better resilience.
## Crop diversity and resilience in village Sanora & Barodi, Datia, MP

### Simpson's Index area (n)

<table>
<thead>
<tr>
<th>Simpson's Index area (n)</th>
<th>Income during a normal year (Lakh Rs./HH)</th>
<th>Income during a stress year (Lakh Rs./HH)</th>
<th>Income resilience</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.25(1)</td>
<td>1.67</td>
<td>0.56</td>
<td>0.34</td>
</tr>
<tr>
<td>0.25 - 0.5(2)</td>
<td>0.34</td>
<td>0.15</td>
<td>0.44</td>
</tr>
<tr>
<td>0.5 - 0.75(23)</td>
<td>1.94</td>
<td>0.81</td>
<td>0.42</td>
</tr>
<tr>
<td>&gt; 0.75(19)</td>
<td>4.54</td>
<td>3.03</td>
<td>0.67</td>
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<tr>
<td>0 - 0.25(1)</td>
<td>0.41</td>
<td>0.14</td>
<td>0.34</td>
</tr>
<tr>
<td>0.25 - 0.5(2)</td>
<td>0.20</td>
<td>0.07</td>
<td>0.35</td>
</tr>
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<td>0.30</td>
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<td>0.22</td>
<td>0.67</td>
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Dealing with Floods & Cyclones

- Renovation of drainage channels
- Land configuration and planting techniques
- Flood tolerant cultivars
- Post flooding management practices
- Prevention of diseases & vaccination in animals
- Shelter management for animals
Minimizing Green house gas emissions through alternative technologies

- Baler for making bundles to biomass based power plants as fuel
- Straw chopper cum shredder-zero till sowing (ZT)
- Paddy combine harvester with straw management system (ZT)
- Rotavator for incorporation of paddy straw
- Reversible MB plough
- Use of straw as livestock feed and bedding material
- Use of straw as soil mulch in orchards

26 villages in 2017 were made residue burning Free in Punjab, Haryana
Micro-level Agromet Advisory Services (MAAS)

- Block level Agromet advisory bulletins disseminated through Field Information Facilitators (FIFs) across 20 States

- This helped in timely decision making for various field operations and minimizing risks
Institutional Interventions

- Village Climate Risk Management Committee (VCRMC)
- Custom Hiring Center (CHC)
- Seed Bank
- Fodder bank
- Commodity Based Organizations (CBOs)
Assessment of Carbon Balance due to Resilient Practices at village level

Mitigation Co-benefits of adaptation practices is being quantified

Green house gas balance (t CO₂eq / year) from climate resilient practices in the seven adopted villages in Gujarat & Rajasthan

CO₂, CH₄ and N₂O balances (t CO₂eq) from climate resilient practices in the seven adopted villages in Gujarat and Rajasthan
Building Capacities of farmers is key for achieving resilience

- Organised about 14,000 training programs benefiting 3,73,000 farmers.
- Sensitised on various aspects of climate change/variability and impacts on agriculture
- Built capacities on various resilient practices leading to enhancement in their adaptive capacity
Scaling-up of CRVs

- Project on Climate Resilient Agriculture (PoCRA) in state of Maharashtra, 5000 villages, US $ 649 million (World bank)

- Consortium for scaling up climate smart agriculture in South Asia, (C-SUCSeS) by C-CAFS being implemented in eight member states of SAARC, US $ 1.5 million (IFAD)

- Telangana, US $ 9.4 million (GCF/NABARD) under proposal

- Drought proofing in Odisha, US $ 10.21 million (State Govt.) under proposal

- Karnataka, 200 watersheds, US $ 8.6 million (NABARD) under proposal
Lessons learnt from India's experience regarding Climate Resilient Villages

- CRV is a comprehensive and unique approach to manage climatic risks with the involvement of communities
- Provided enabling environment created with the establishment of village institutions
- Natural resource based deployment of technologies is essential for minimizing the impact of climatic variability and change
- In low rainfall regions, crop based resilient practices are relatively promising for achieving resilience
- In medium to high rainfall regions, in-situ coupled with water harvesting and its utilization are key to minimize the impact of drought and to enhance the cropping intensity during favourable seasons
- Creation of water assets and availability lead to multiple benefits by way of diversification and cropping intensification and income gains
- Custom hiring center evolved as community-led mechanism for access to costly machinery/implements is critical for timely implementation of resilient practices in large area
- Intensive capacity and skill development of communities is essential for imparting resilience
- The CRV approach on a medium to long term basis can contribute towards stabilizing the production systems can contribute to food and nutritional security and can mitigate climate change
Challenges in implementing resilience enhancing technologies

• Requires significant quantity of resources for reaching millions of small holders

• Knowledge intensive and requires technical backstopping on a continuous basis

• Response in real time is essential; need infrastructure and technical support for minimizing the impact

• Resilience enhancing technologies are location specific and depends on resource endowments of farmers

• Poor economic status of farmers in climatically vulnerable regions of the country—has impact on adoption

• High cost of resource management resilient technologies—need huge investments
Strengthening Collaboration among G20 Members for Disseminating Climate Resilient Technologies

- Vulnerability assessment to climate change (District level), climate resilient indicators (farm and village level)
- Strengthening capacities in frontier areas of climate change research viz., system approach modelling, down scale ensembled climate change scenarios, AI, PA tools, plant phenomics etc.
- Climate resilient technologies in agriculture & allied sector for adaptation and mitigation
- GHG fluxes at ecosystem level
- Micro (District) level agricultural contingency planning and its country-wide implementation
- Climate resilient villages and its expansion
Thank you