India's Experience on Climate Resilient Villages

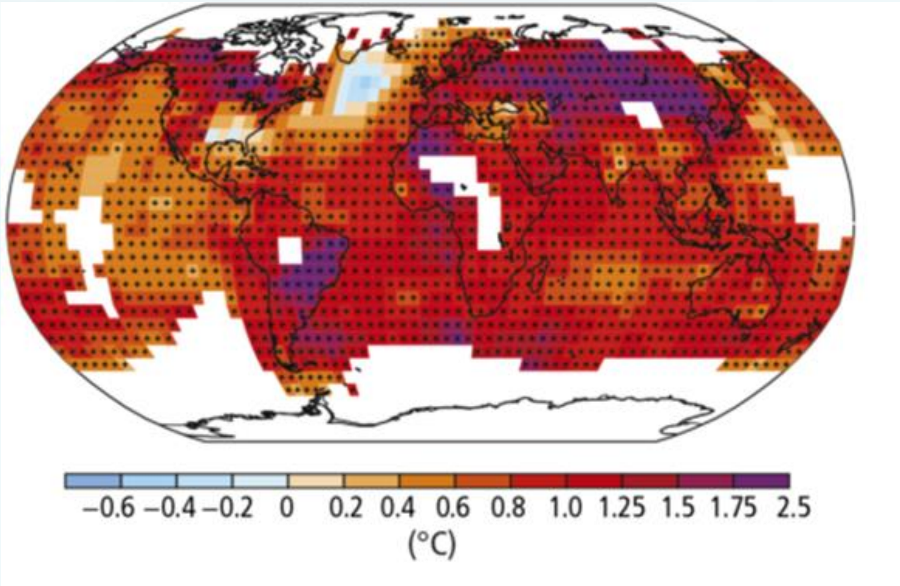
G20 MACS, Japan

Trilochan Mohapatra

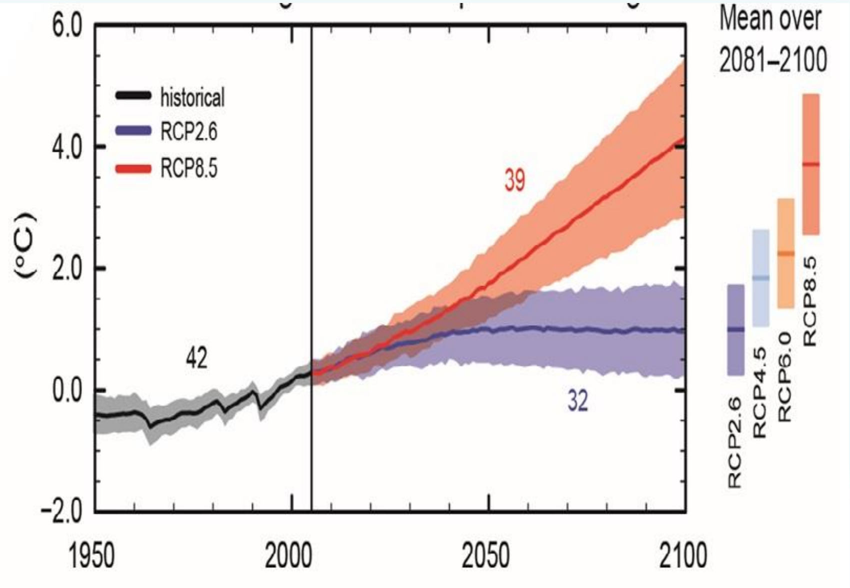
Ministry of Agriculture & Farmers’ Welfare

Govt of India

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



Observed change in surface temperature (1901-2012)



Predicted global average surface temperature rise (^{0} C) up to 2100

Global warming is likely to reach 1.5^{0}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 Artic

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

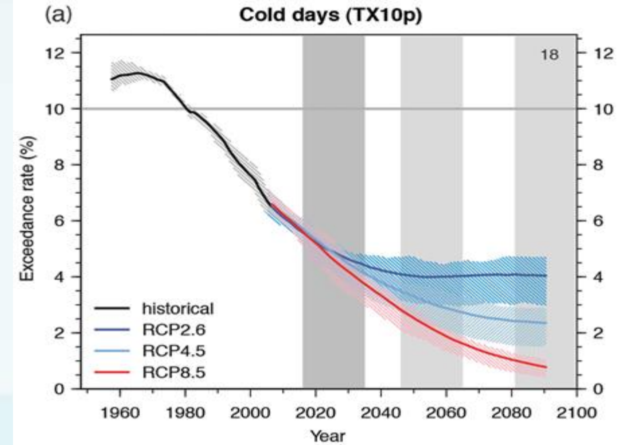
The Greenland and Antarctic ice sheets have been losing mass

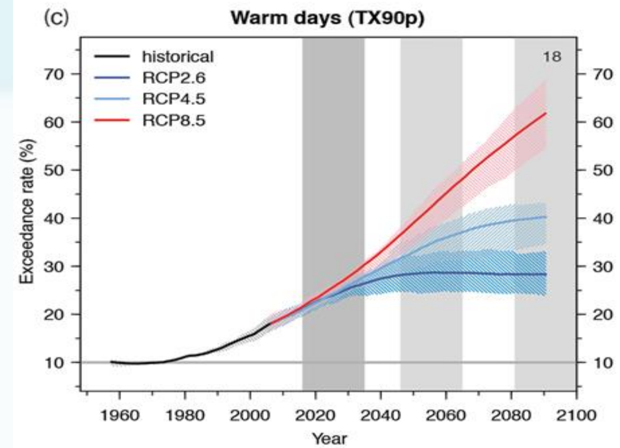
Glaciers have continued to shrink globally

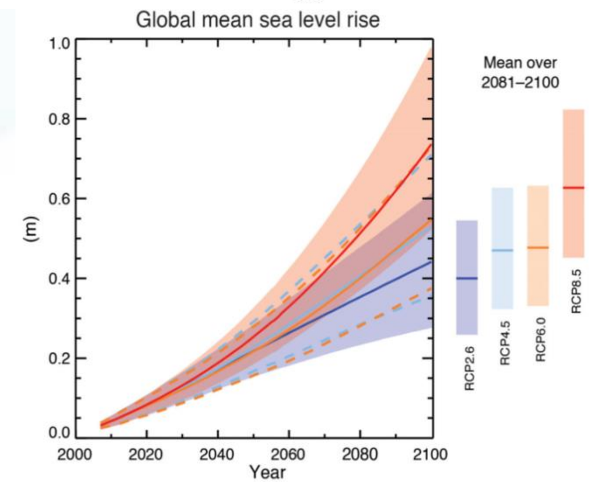
Global sea level rose by 0.19 m between 1901 and 2010

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

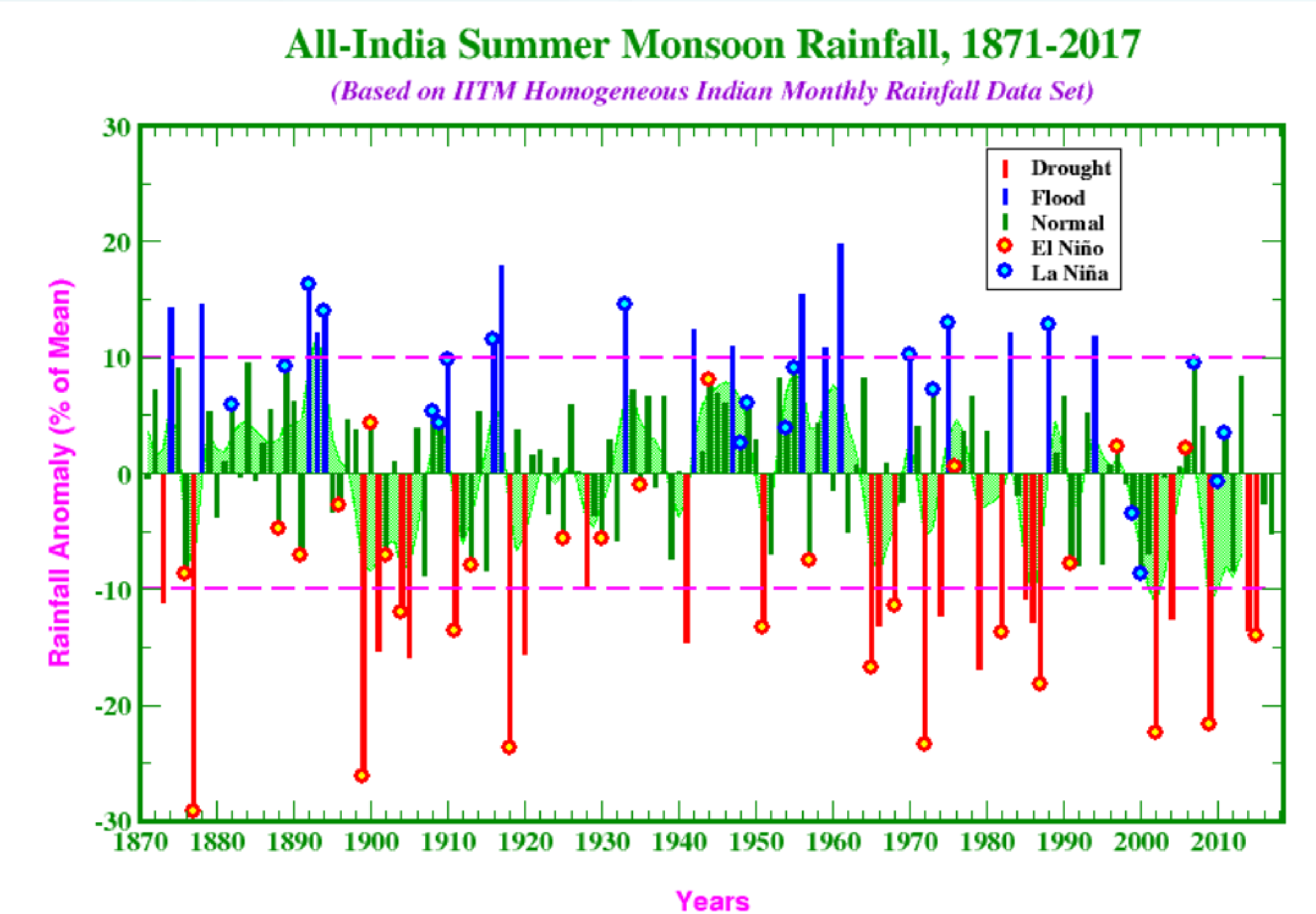






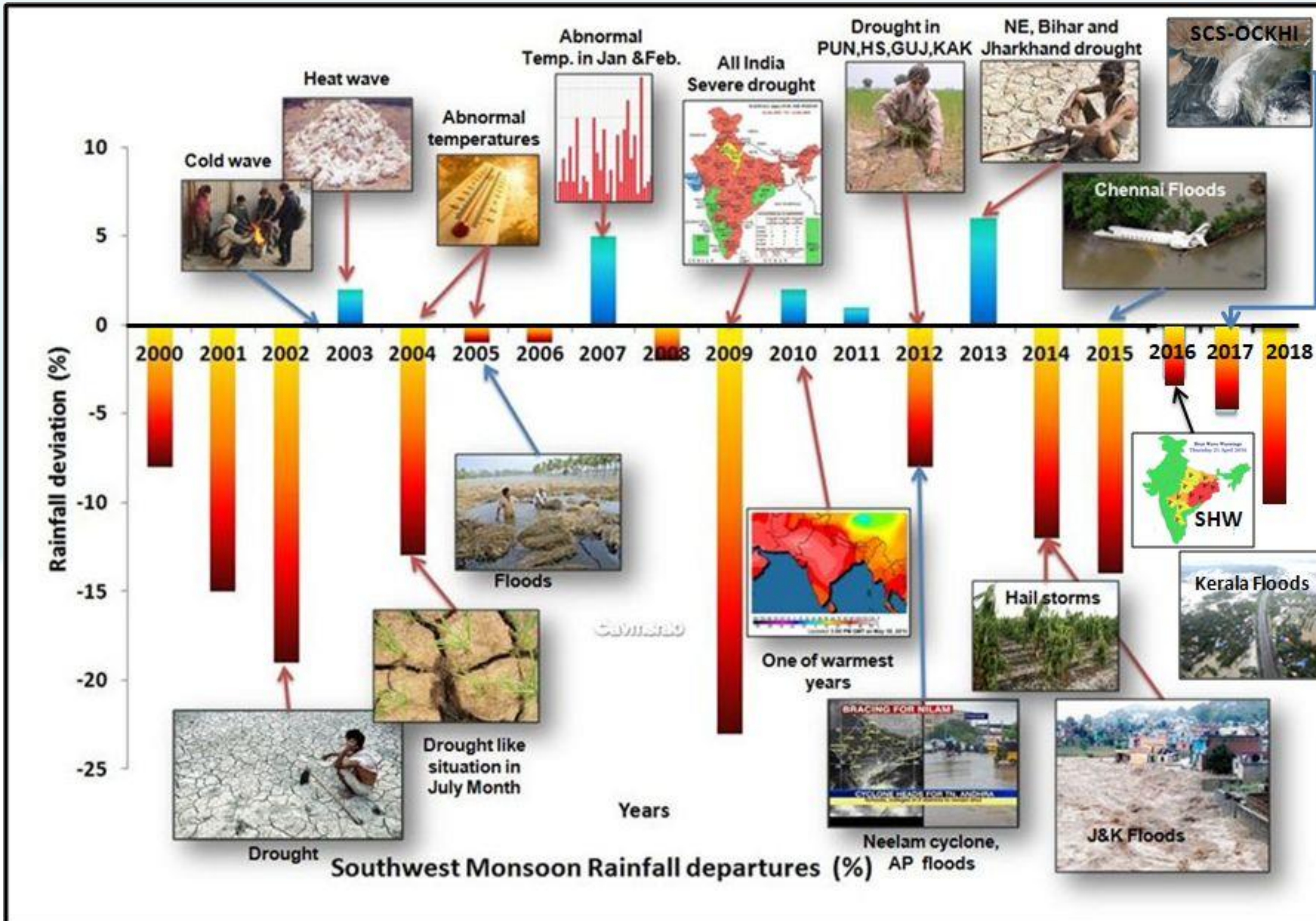
Source: IPCC 2013

Rainfall variability, frequency of *El Nino* and droughts is increasing



No. of years experienced drought 1870-1939: 10 where as during 1940-2010:15

Extreme Events in the recent past (India)



Impact of Climate Change on Agriculture in India

Commodity	Projected Impact
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^{o}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^{o}C along the Indian coast in the last 45 years, and is projected to increase by 2.0 to 3.5^{o}C by 2099 ▪ Latitudinal extension in abundance, spawning, breeding activity of several species to be affected

National Innovations in Climate Resilient Agriculture (NICRA)

A Flagship Project of ICAR

(Launched in 2011)

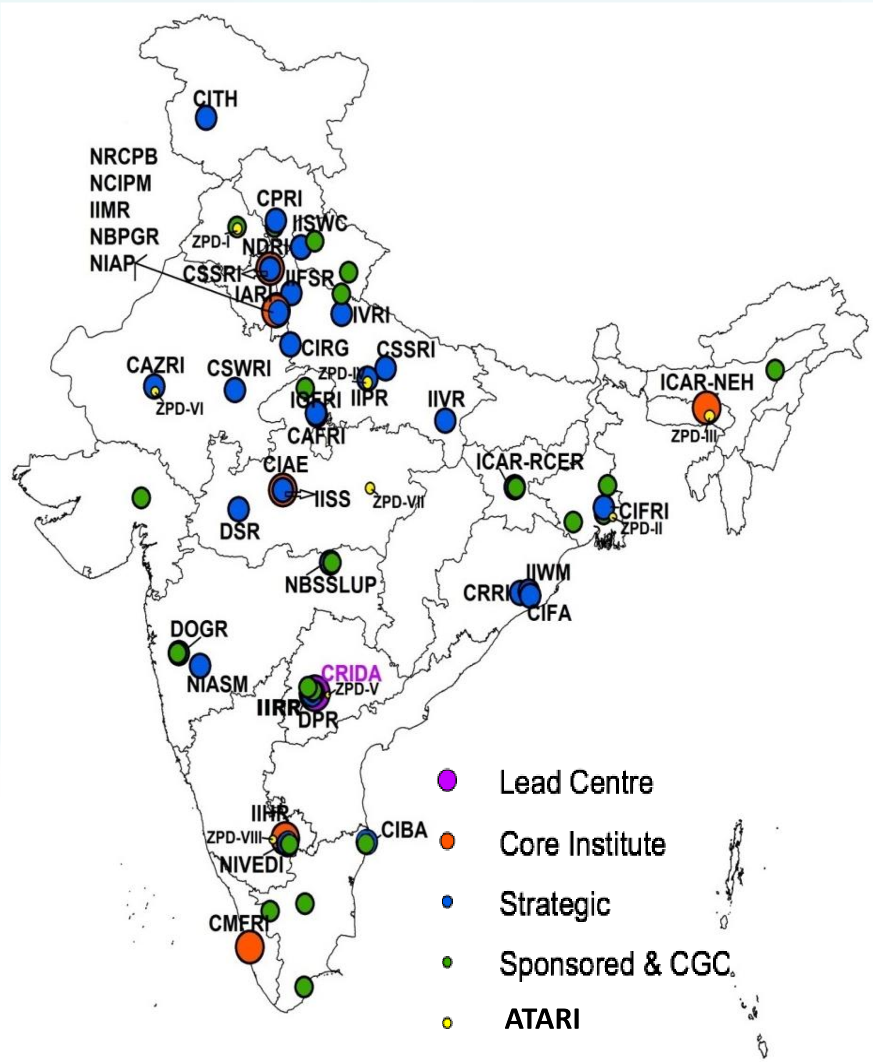
Objectives

- 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

NICRA Network



Components

Research

- Strategic (41ICAR Insts., IITs, SAUs, Traditional Universities)
- Sponsored Grant (2)
- Competitive Grant (26)

Technology Demo (151 CRVs)

- 121 Farm Sci. Centres (11 ATARIs)
- 23 Dryland Centres
- 7 ICAR Institutes

Capacity Building

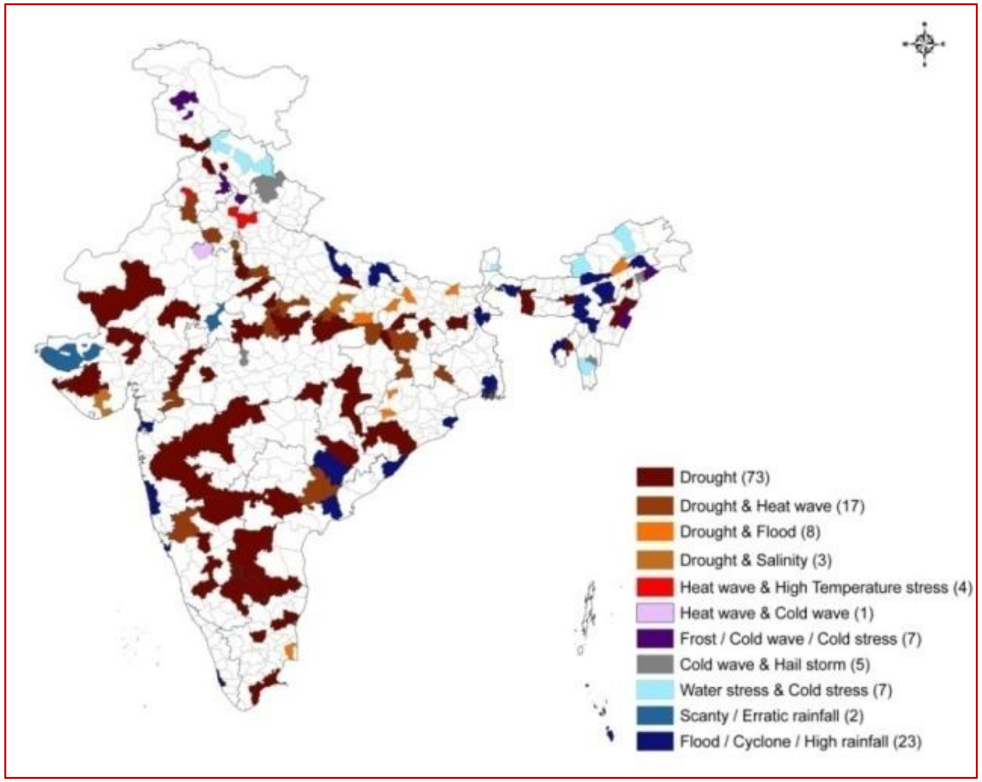
- Farm Sci. Centres
- ICAR Inst.
- Agril. Universities

- 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



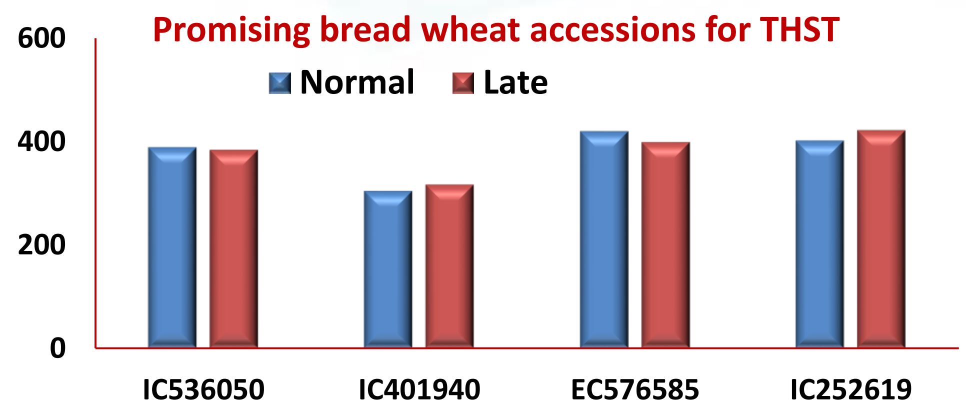
151 Climate Resilient Villages in vulnerable districts

While achieving the above objectives, Climate Resilient Village approach was evolved

Screening Agro-biodiversity for Climate Resilience

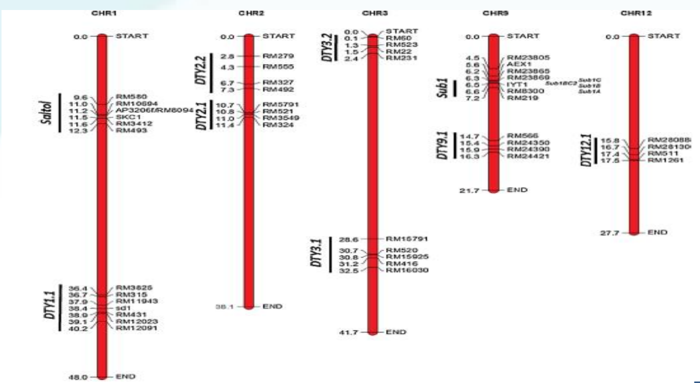
Region (Climatic condition)	Crop	Varieties
Mid & high hills (Delayed rains)	Buckwheat	VL-7, Himgiri
Mid & high hills (Low rain fall)	Grain amaranth	Annapurna, Durga, PRA-1, PRA-2, VL Chua 44
Mid & high hills (Mixed crops in apple orchards)	Chenopodium	Him Bhathua
Mid & lower hills (Sub humid/humid)	Rice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

316 wheat accessions for terminal heat stress tolerance



Developing Multiple Stress Tolerance for Climate Resilience and Sustainability

- Molecular Breeding
- Climate Smart Varieties
  - ✓ Productivity
  - ✓ Livelihoods



Marker-assisted backcross breeding

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Genetic Yield Potential Enhancement

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From QTL to variety-harnessing the benefits of QTLs for drought, flood and salt tolerance in mega rice varieties of India through a multi-institutional network

Renu Singh[a], Yashi Singh[a], Suchit Xalaxo[b], S. Verulkar[b], Neera Yadav[a], Shweta Singh[a], Nisha Singh[a], K.S.N. Prasad[c], K. Kondayya[c], P.V. Ramana Rao[c], M. Girija Rani[c], T. Anuradha[c], Y. Suraynarayana[c], P.C. Sharma[d], S.L. Krishnamurthy[d], S.K. Sharma[d], J.L. Dwivedi[e], A.K. Singh[e], P.K. Singh[f], Nilanjay[g], N.K. Singh[g], Rajesh Kumar[g], S.K. Chetia[h], T. Ahmad[h], M. Rai[i], P. Perraju[j], Anita Pande[k], D.N. Singh[k], N.P. Mandal[l], J.N. Reddy[l], O.N. Singh[l], J.L. Katara[l], B. Marandi[l], P. Swain[l], R.K. Sarkar[l], D.P. Singh[l], T. Mohapatra[l], G. Padmawathi[m], T. Ram[m], R.M. Kathiresan[n], K. Paramsivam[o], S. Nadarajan[o], S. Thirumeni[o], M. Nagarajan[p], A.K. Singh[q], Prashant Vikram[r], Arvind Kumar[r], E. Septiningshih[r], U.S. Singh[r], A.M. Ismail[r], D. Mackill[r], Nagendra K. Singh[a,*]

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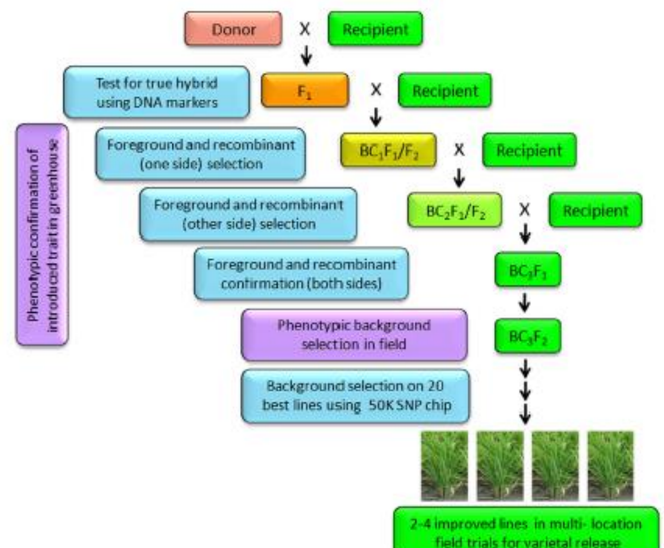

* Corresponding author.

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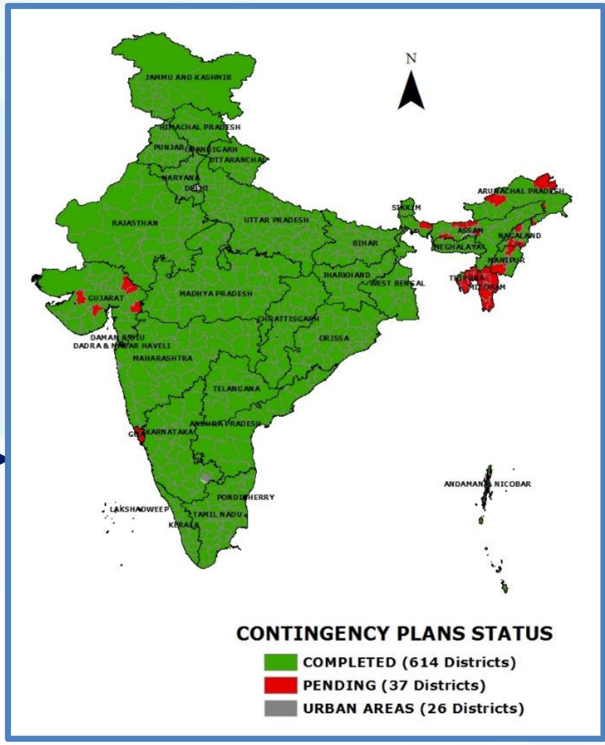
District Agriculture Contingency Plans

(623 of 651 completed)

Updating of contingency plans with Universities/KVKs

NICRA/CRIDA/ AICRPDA Research outputs & Agri. 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

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

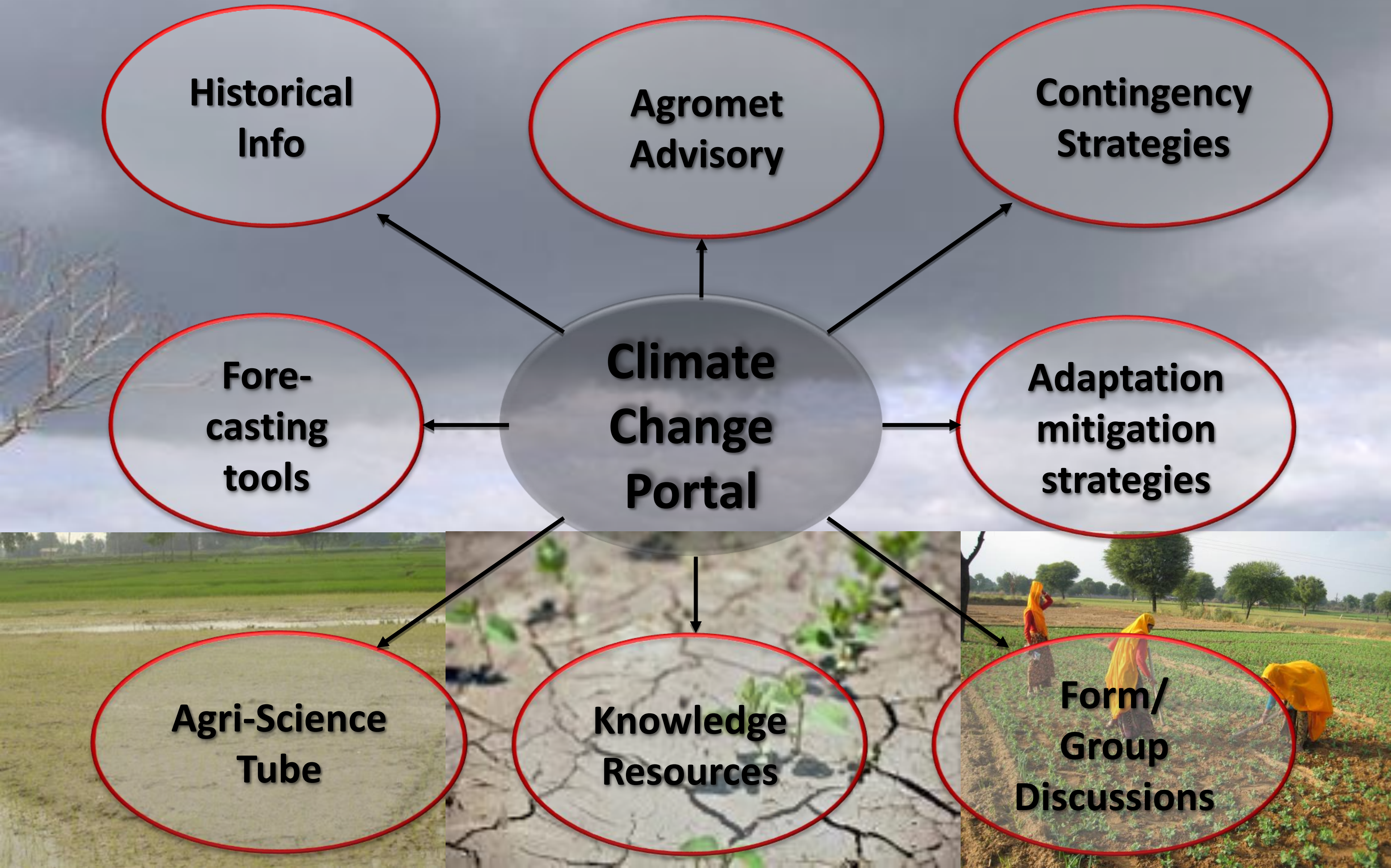




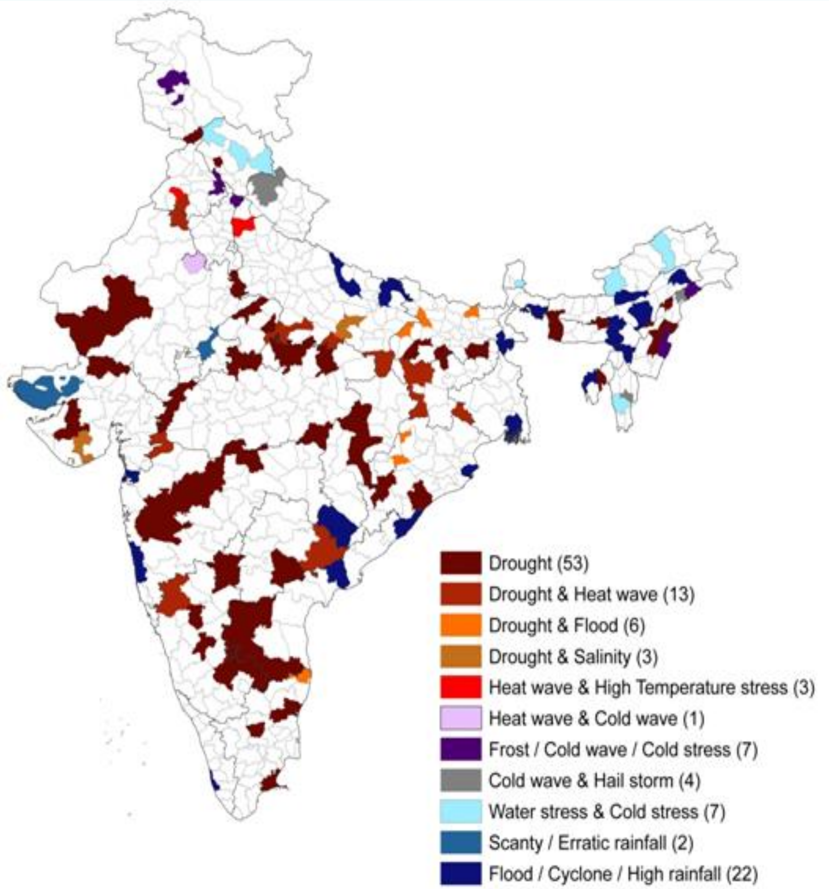


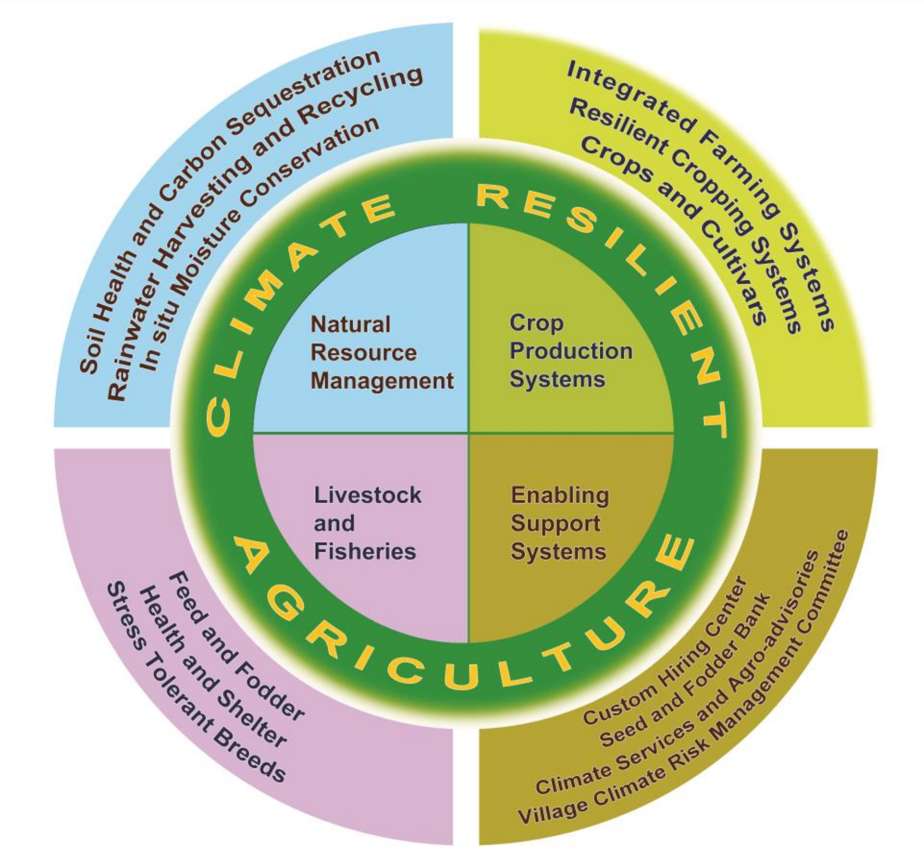


Climate Change and Agriculture Knowledge Portal



Climate Resilient Villages



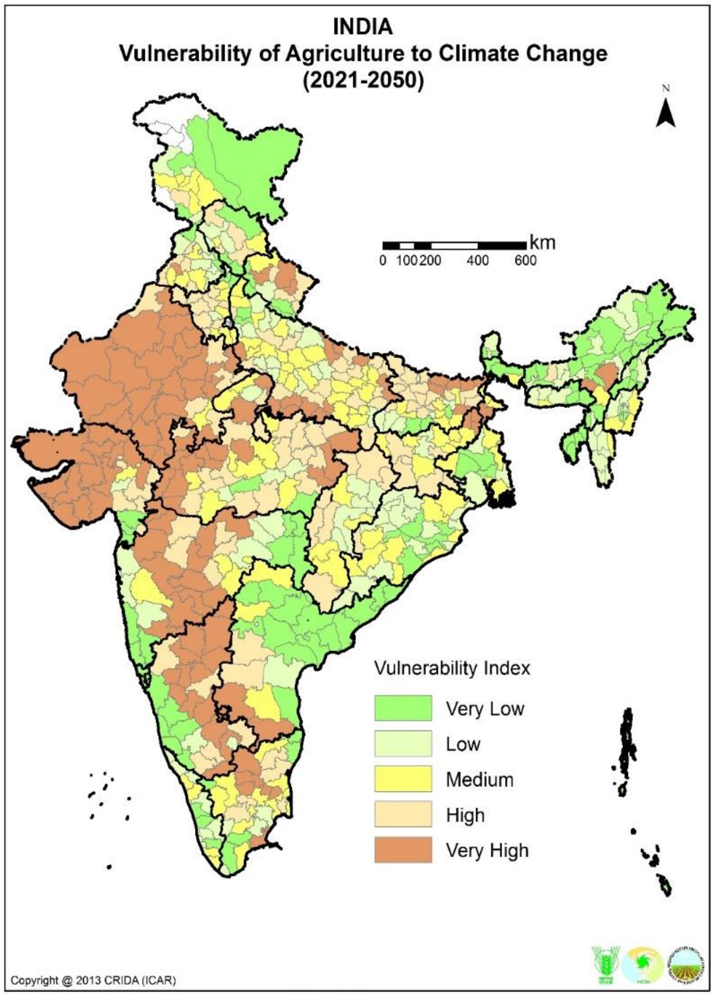


151 Climate Resilient Villages Established

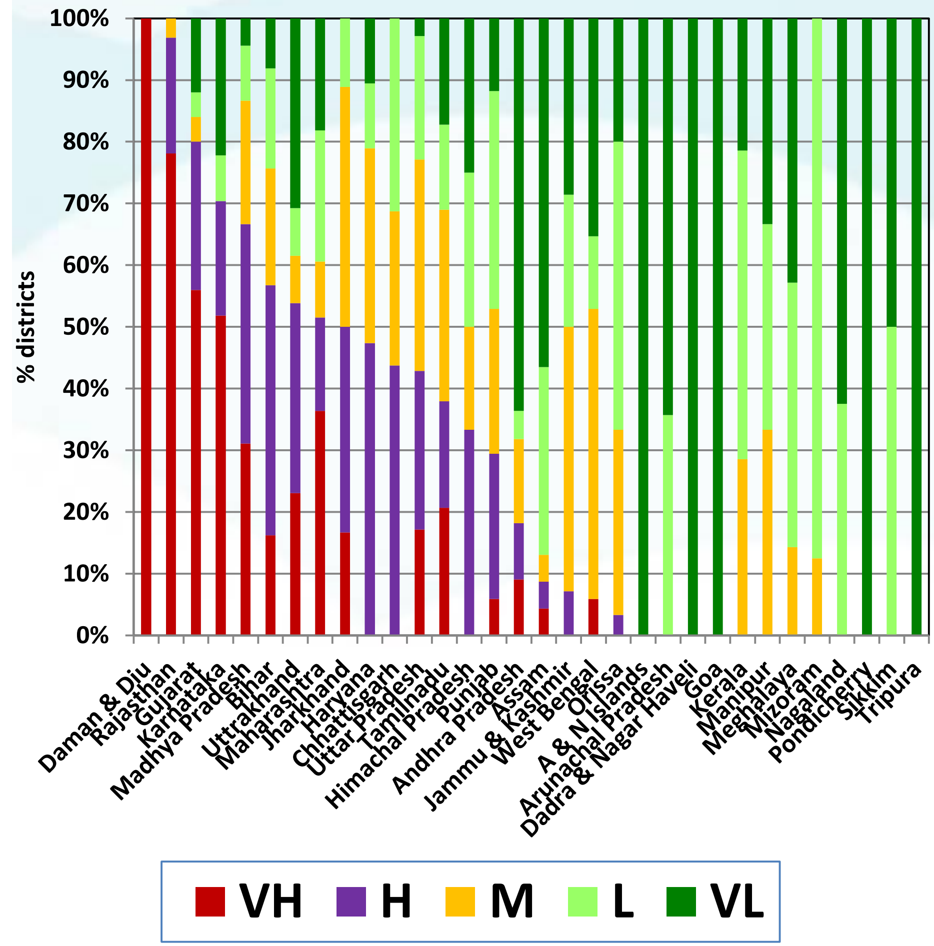
Modules & Major Interventions in Climate Resilient Village

Selection of CRVs

Vulnerability Atlas has been prepared and vulnerable districts were selected

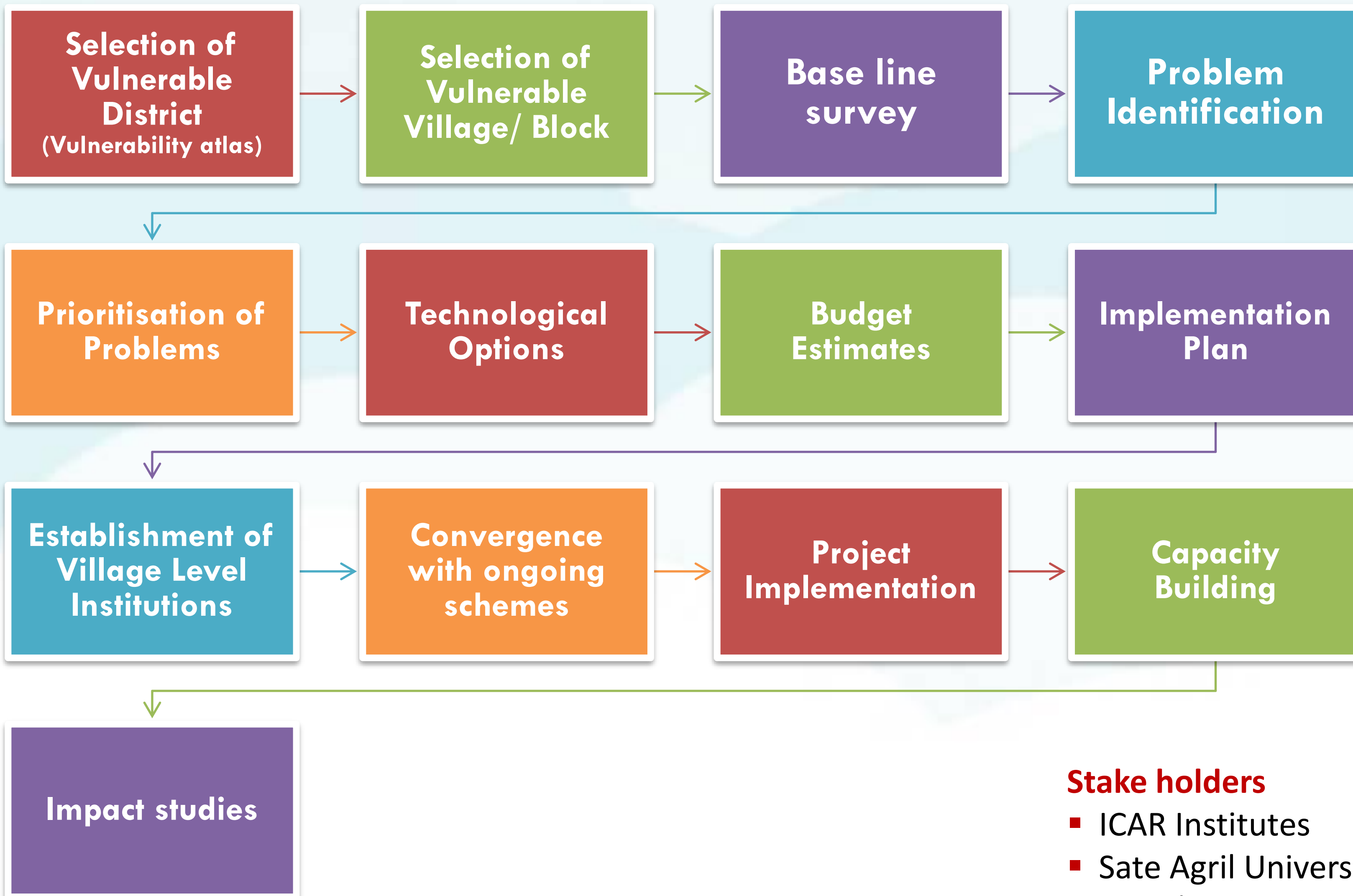


State-wise distribution of districts with different levels of vulnerability



About 229 districts were found to be high to very highly vulnerable to climate change

Process of Establishing Climate Resilient Villages



Stake holders

- ICAR Institutes
- Sate 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. Documenation 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

Manuring

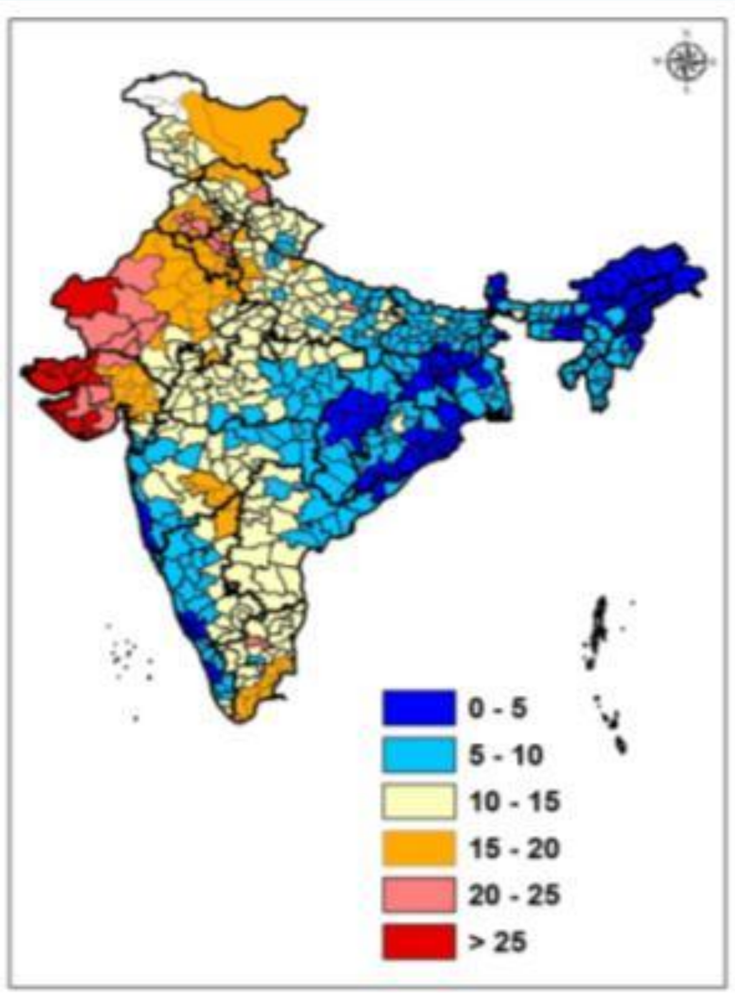
Carbon

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



Regions of frequent Drought occurrence

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)

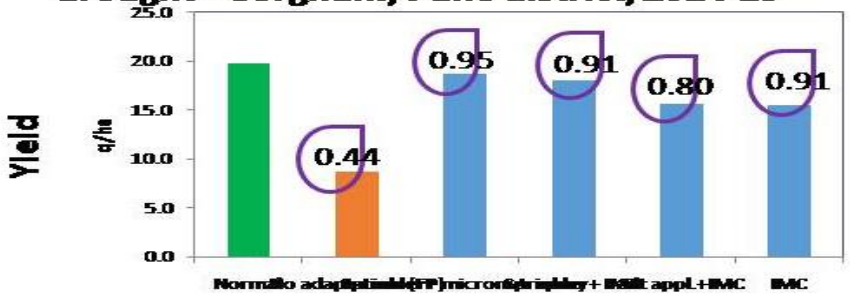
- Resilience 1: Proportion of normal yield = Yield obtained in stress/normal yield
- Resilience 2: Proportion of yield loss avoided [1 – ((normal yield – yield with adaptation) / (normal yield - yield with no adaptation)]

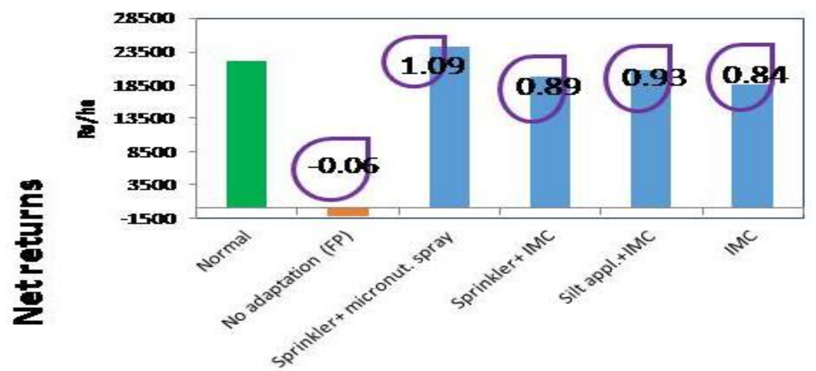
Village level (process based measure)

- 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

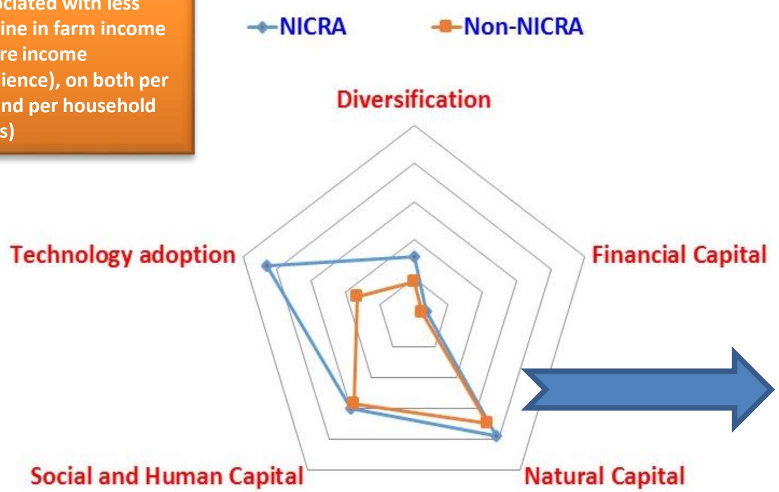
Adaptation Interventions and resilience to drought – Sorghum, Pune district, 2014-15



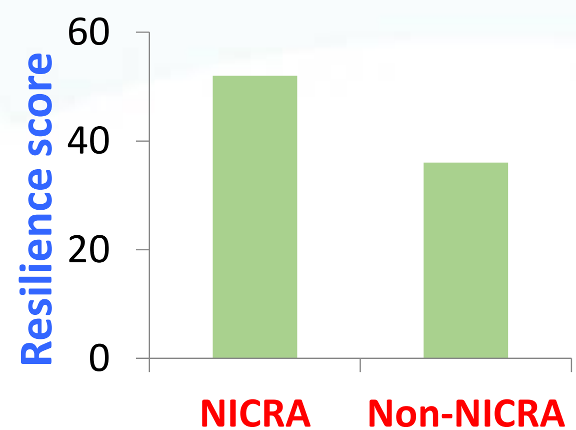


During a drought year, different adaptation interventions gave a yield closer to the 'normal yield' compared to 'no adaptation'; IMC=In-situ moisture conservation

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



NICRA village did better with respect to indicators related to technology adoption and showed better resilience



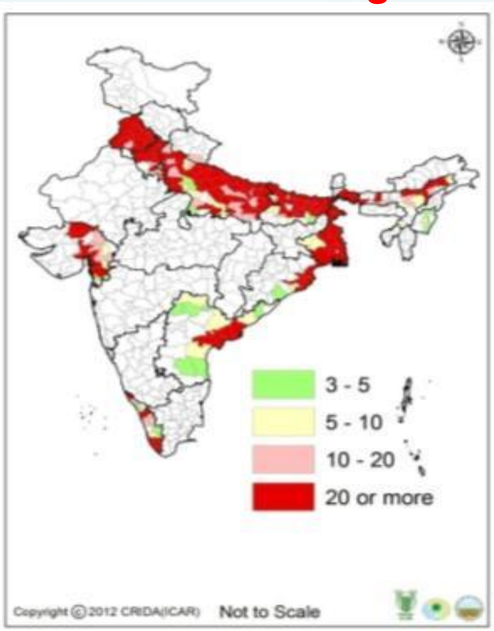
Crop diversity and resilience in village Sanora & Barodi, Datia, MP

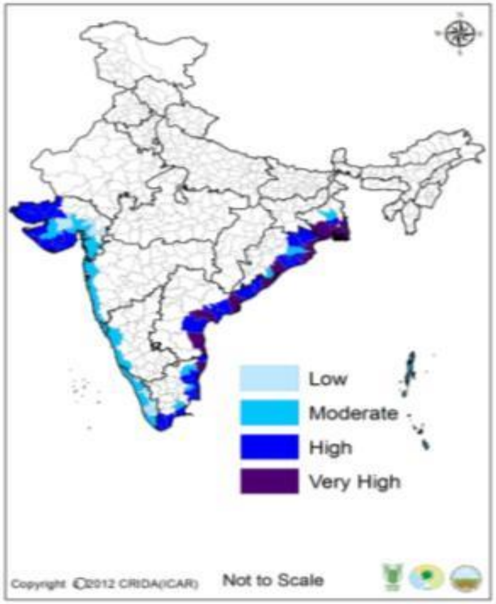
Simpson's Index area (n)	Income during a normal year (Lakh Rs. /HH)	Income during a stress year (Lakh Rs./HH)	Income resilience
0 - 0.25(1)	1.67	0.56	0.34
0.25 - 0.5(2)	0.34	0.15	0.44
0.5 - 0.75(23)	1.94	0.81	0.42
> 0.75(19)	4.54	3.03	0.67

Simpson's Index area (n)	Income during a normal year (Lakh Rs./Ha)	Income during a stress year (Lakh Rs./Ha)	Income resilience
0 - 0.25(1)	0.41	0.14	0.34
0.25 - 0.5(2)	0.20	0.07	0.35
0.5 - 0.75(23)	0.30	0.16	0.52
> 0.75(19)	0.34	0.22	0.67

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

Flood affected regions





Cyclone affected regions

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

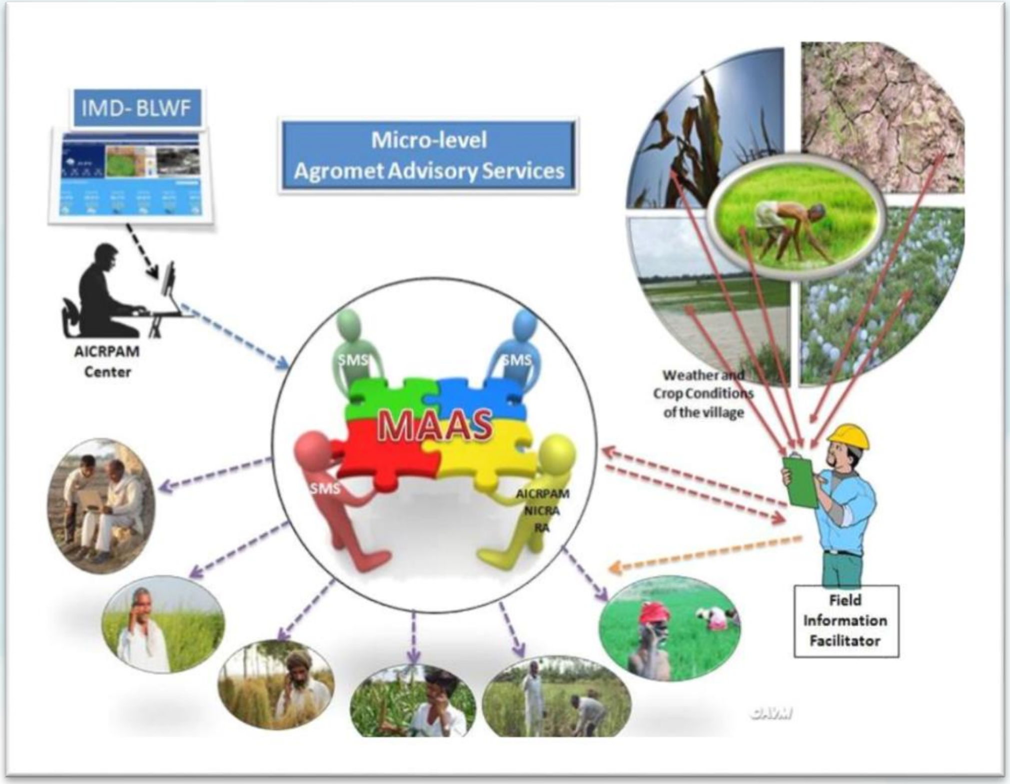
Alternatives to straw burning

- 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)

Conceptualization and Implementation

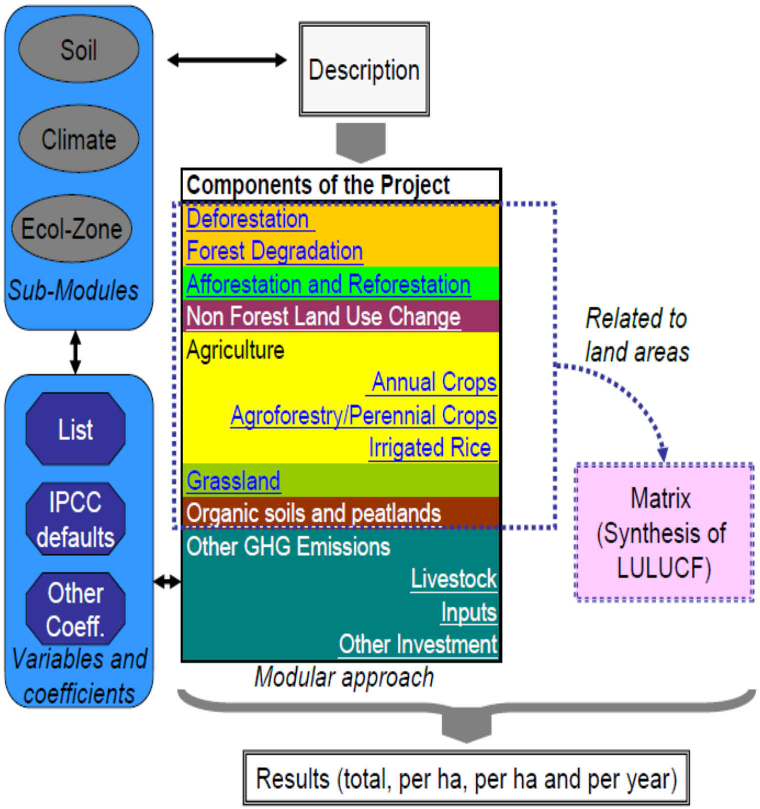


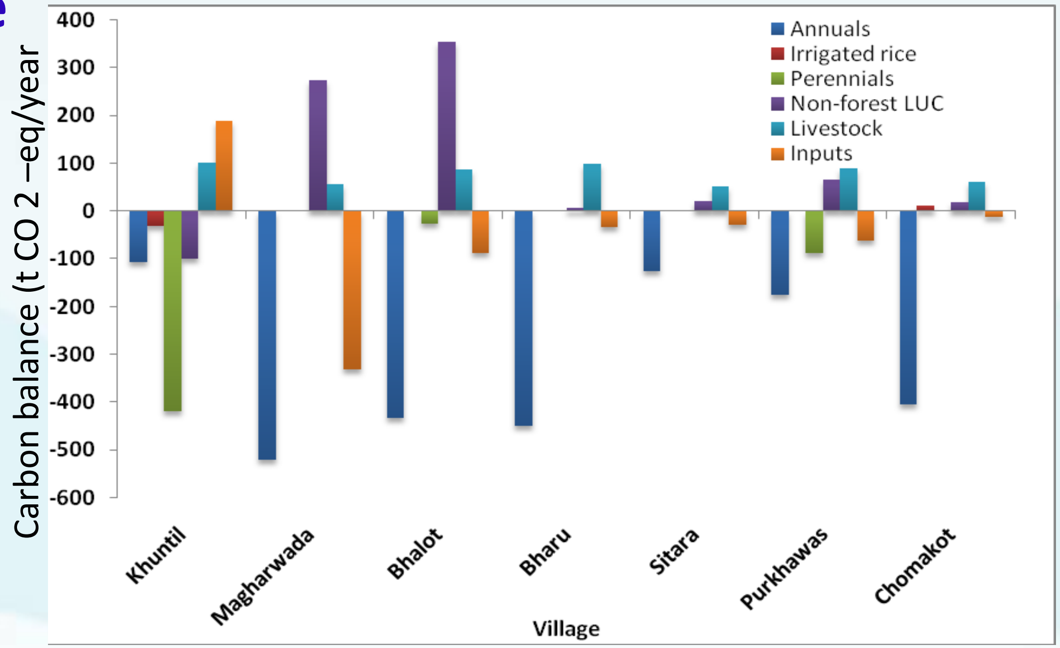
- Block level Agromet advisory bulletins disseminated through Field Information Facilitators (FIFs) across 20 States
- This helped in timely decision making for various field operations and minimizing risks

Institutional Interventions

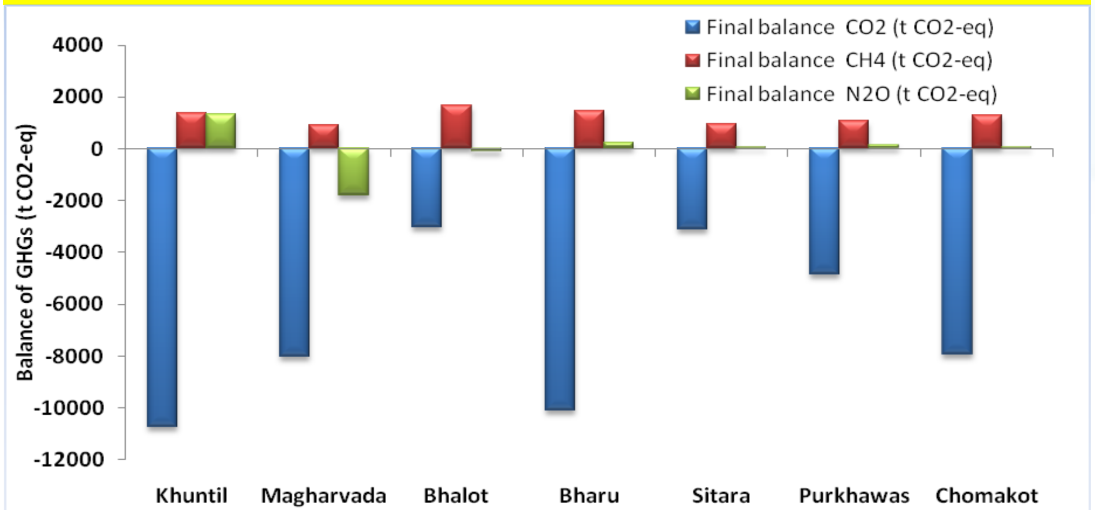
- Village Climate Risk Management Committee (VCRMC)
- Custom Hiring Center (CHC)
- Seed Bank
- Fodder bank
- Commodity Based Organizations (CBOs)

Assessment of Carbon Balance due to Resilient Practices at village level





Green house gas balance (t CO_2eq / year) from climate resilient practices in the seven adopted villages in Gujarat & Rajasthan



CO_2, CH_4 and N_2O balances (t CO_2-eq) from climate resilient practices in the seven adopted villages in Gujarat and Rajasthan

Mitigation Co-benefits of adaptation practices is being quantified

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

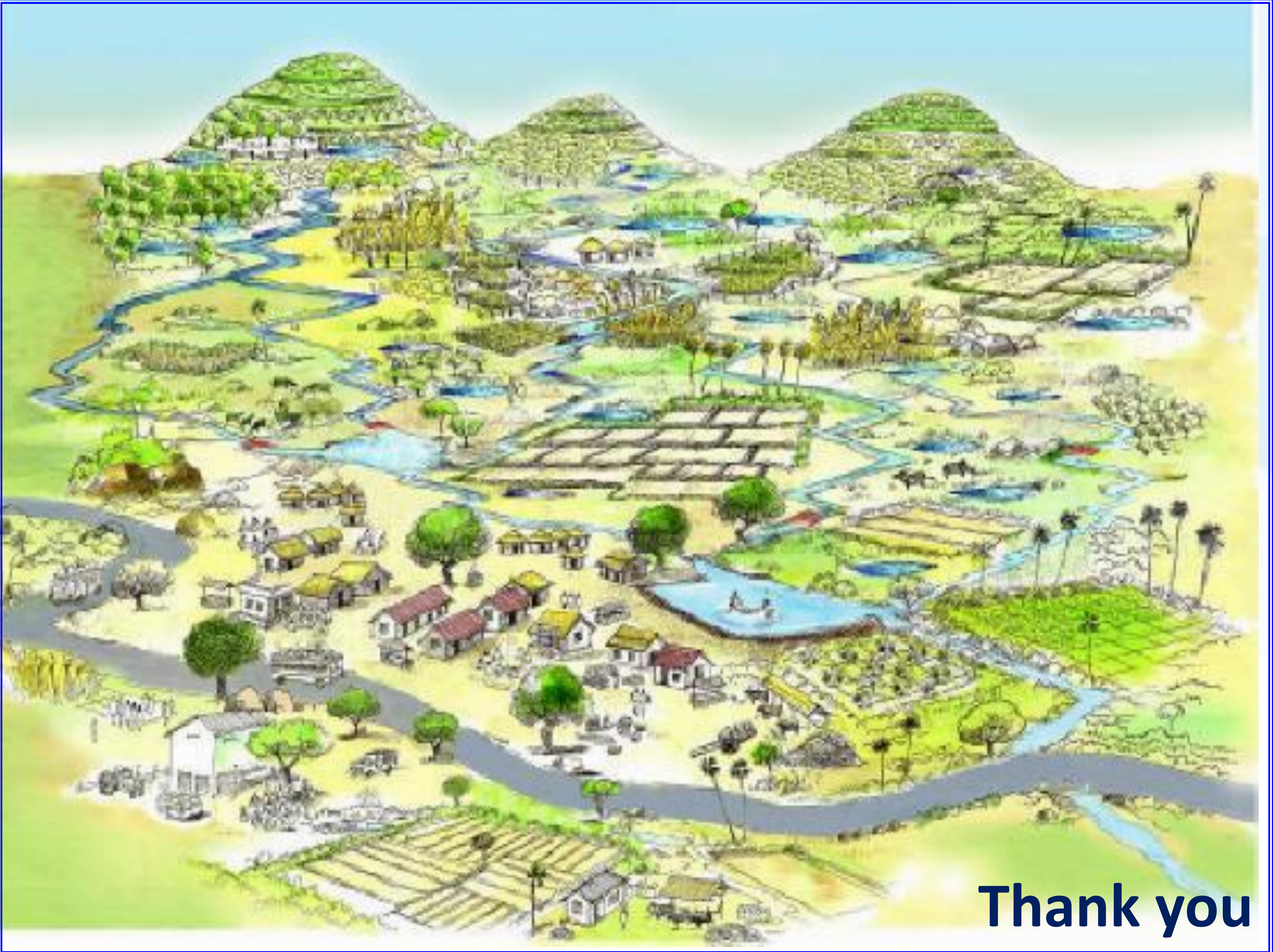
- CRV is a comprehensive and unique approach to manage climatic risks with the involvement of communities
- Provided enabling environment created with the establishment of village institutions
- Natural resource based deployment of technologies is essential for minimizing the impact of climatic variability 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