Adaptation of Agriculture to Climate Change Mitigation

Ch. Srinivasa Rao
Director

ICAR-Central Research Institute for Dryland Agriculture
Hyderabad
Weather Aberrations in India

- Increasing attention on climate change impacts and vulnerability in the agricultural sector

- **India is no exception** of experiencing such weather aberrations with high impacts

- A stronger focus on *adapting agriculture to current and future climate change*

- For this, simultaneous *short term and long term strategies* are needed

- **Short term responses - Real time contingencies** to cope with seasonal weather aberrations for higher farm productivity, food security at household level

- **Long-term strategies – for mitigation of climate change** besides having farm level impacts
Agricultural production in India is closely linked to the performance of summer monsoon (June to September) which contributes about 75% of the annual precipitation.
Most districts along the eastern and western coast, north-eastern states are less vulnerable

By mid-century (2021-2050), districts in Rajasthan, Gujarat, Madhya Pradesh, Karnataka, Maharashtra, Andhra Pradesh, Tamil Nadu, eastern Uttar Pradesh and Bihar exhibit very high and high vulnerability.

Towards end of the century (2071-2098), almost all districts in Rajasthan and many districts in Gujarat, Maharashtra, Karnataka exhibit very high vulnerability.
November 1958 - November 2015

Atmospheric CO₂

November CO₂ | Year Over Year | Mauna Loa Observatory

Nov. 2015 400.16
Nov. 2014 397.27
Nov. 2013 395.11

CO₂·earth Featuering NOAA-ESRL data of December 7, 2015
### Food demand projections of different studies for India

<table>
<thead>
<tr>
<th>Source of study</th>
<th>Year</th>
<th>Rice</th>
<th>Wheat</th>
<th>Total cereals</th>
<th>Pulses</th>
<th>Food grains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bansil (1996)</td>
<td>2020</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>241.4</td>
</tr>
<tr>
<td>Kumar (1998)</td>
<td>2020</td>
<td>134.0</td>
<td>127.3</td>
<td>309.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Paroda and Kumar (2000)</td>
<td>2020</td>
<td>111.9</td>
<td>79.9</td>
<td>229.0</td>
<td>23.8</td>
<td>252.8</td>
</tr>
<tr>
<td>Radhakrishna and Reddy (2004)</td>
<td>2020</td>
<td>118.9</td>
<td>92.4</td>
<td>221.1</td>
<td>19.5</td>
<td>240.6</td>
</tr>
<tr>
<td>Mittal (2008)</td>
<td>2021</td>
<td>96.8</td>
<td>64.3</td>
<td>245.1</td>
<td>42.5</td>
<td>287.6</td>
</tr>
<tr>
<td></td>
<td>2026</td>
<td>102.1</td>
<td>65.9</td>
<td>277.2</td>
<td>57.7</td>
<td>334.9</td>
</tr>
<tr>
<td>Kumar et al (2009)</td>
<td>2021-22</td>
<td>113.3</td>
<td>89.5</td>
<td>233.6</td>
<td>19.5</td>
<td>253.2</td>
</tr>
<tr>
<td>Amarasinghe and Singh (2009)</td>
<td>2025</td>
<td>109</td>
<td>91</td>
<td>273</td>
<td>18</td>
<td>291.0</td>
</tr>
<tr>
<td>Singh (2009)</td>
<td>2050</td>
<td>117</td>
<td>102</td>
<td>356</td>
<td>21</td>
<td>377.0</td>
</tr>
<tr>
<td>Singh (2013)</td>
<td>2020</td>
<td>106.7</td>
<td>85.7</td>
<td>220.0</td>
<td>23.2</td>
<td>243.2</td>
</tr>
</tbody>
</table>
Projected changes in crop yields (%) at maximum changes in temperature and rainfall by 2035, 2065 and 2100

<table>
<thead>
<tr>
<th>Crop</th>
<th>2035</th>
<th>2065</th>
<th>2100</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rainy season</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td>-7.1</td>
<td>-11.5</td>
<td>-15.4</td>
</tr>
<tr>
<td>Maize</td>
<td>-1.2</td>
<td>-3.7</td>
<td>-4.2</td>
</tr>
<tr>
<td>Sorghum</td>
<td>-3.3</td>
<td>-5.3</td>
<td>-7.1</td>
</tr>
<tr>
<td>Pigeonpea</td>
<td>-10.1</td>
<td>-17.7</td>
<td>-23.3</td>
</tr>
<tr>
<td>Groundnut</td>
<td>-5.6</td>
<td>-8.6</td>
<td>-11.8</td>
</tr>
<tr>
<td><strong>Winter season</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>-8.3</td>
<td>-15.4</td>
<td>-22.0</td>
</tr>
<tr>
<td>Barley</td>
<td>-2.5</td>
<td>-4.7</td>
<td>-6.8</td>
</tr>
<tr>
<td>Chickpea</td>
<td>-10.0</td>
<td>-18.6</td>
<td>-26.2</td>
</tr>
<tr>
<td>Rapeseed-mustard</td>
<td>0.3</td>
<td>0.7</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Maximum changes in temperature and rainfall are 1.3° & 7% by 2035, 2.5° & 26% by 2065 and 3.5° & 27% by 2100, respectively (Source: Adapted from Birthal et al., 2014)
Weather aberrations and affected agriculture sector

- Cyclone
- Heat wave
- Hailstorm
- Sea water inundation
- Drought
- Floods
- Field crops
- Horticulture
- Livestock
- Poultry
- Fisheries
India

Food Security

1.3 Billion +
Indians

Marginal Lands
Declining Per Capita Land Availability
Socio-economic structure
Markets & Price

Productivity vs Food Security
Climate Variability
Climate Change

@ Droughts
@ Cyclones/Floods
@ Heat wave
@ Hail storms
@ Frost

* 270 million tons +
* Imports of food legumes and edible oils

Hunger Malnutrition
Integrated Genetic Natural Resource Management (IGNRM): Key Adaptation Strategy for Weather Aberrations

Impact

- Improved management + Existing variety
- Existing Management + Improved variety
- BMP's (soil, water, crop) with stress tolerant variety
Climate Resilient Villages in India

- 121 implementation sites by KVKs
- 7 Core Research Institutes
- 23 AICRPDA Centres

Climate Vulnerabilities addressed:

- Drought (73)
- Drought & Heat wave (17)
- Drought & Flood (8)
- Drought & Salinity (3)
- Heat wave & High Temperature stress (4)
- Heat wave & Cold wave (1)
- Frost / Cold wave / Cold stress (7)
- Cold wave & Hail storm (5)
- Water stress & Cold stress (7)
- Scanty / Erratic rainfall (2)
- Flood / Cyclone / High rainfall (23)
Conceptual outlay of CRVs

- Better Crop Management
- Conserving Natural Resources
- Livestock Production
- Agro-Advisories
- Integrated Farming Systems
- Adaptation to Weather Aberration & Extreme Events
- Household/Village Food Security/Sustainable Development
- Climate Change Mitigation

Srinivasarao et al. (2016)
Components and technology framework of CRVs

**Climate Resilient Village**

**Weather**
1. Village based rain gauge
2. Automatic weather stations
3. Weather based agro-advisory
4. Doc. of aberrant weather conditions
5. Climate awareness

**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

**Crop**
1. Drought & flood tolerant varieties
2. Salinity tolerant cultivars
3. Intercropping
4. Crop diversification
5. Planting methods

**Fertilizer**
1. Soil health cards
2. SSNM
3. Legumes
4. INM
5. Precision applicatn
6. Coated fertilizer

**Carbon**
1. Village organic resource inventory
2. Residue recycling
3. CA
4. Tank silt application
5. Agroforestry
6. Livestock management

**Institutional/ Knowledge**
1. VCRMC
2. CHC
3. Seed and fodder banks
4. Commodity interest groups
5. Community nursery
6. Capacity building

Srinivasarao *et al.* (2016)
Framework for developing climate resilient villages

- In-situ moisture conservation
- Rainwater harvesting & recycling
- Soil health
- Carbon sequestration
- Resource conservation technologies

- Stress tolerant & short duration cultivars
- Resilient crops & cropping systems
- Planting & water saving methods
- Adjustments in planting time of rabi crops
- Soil test based nutrient application
- Integrated farming systems

- Stress tolerant breeds
- Feed & fodder
- Shelter & health

- Village Climate Risk Management Committee (VCRMCs)
- Custom Hiring Centre for farm implements
- Seed & fodder banks
- Climate information and agro-advisory services

Evidence, metrics, resilience, indicators, barriers for adaptation, trade-offs, synergies & scalability

Natural Resource Management

Crop Production Systems

Livestock and Fisheries

Prioritization of context- and location-specific practices/technologies

Enhanced Adaptive Capacity

Resilient Production Systems

Resilient Households and Landscapes

Srinivasarao et al. (2016)
Village level institutional setup in CRVs

- Village seed bank
- Fodder bank
- AWS (Mobile groups)
- VCRMC
- CHC
- Commodity groups

Srinivasarao et al. (2016)
Challenge is to sow and establish a crop

Major options

• Alternate crops
• Short duration varieties

Beyond the sowing window, choice of alternate crops or cultivars depends on the farming situation, soil, rainfall and cropping pattern in the location and extent of delay in the onset of monsoon.
**Delayed onset of Monsoon: Prefer Resilient Crops & Varieties**

<table>
<thead>
<tr>
<th>Centre (State)</th>
<th>Delay in onset by</th>
<th>Crop</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chianki (Jharkhand)</td>
<td>21 days</td>
<td>Rice</td>
<td>IR 92521-7-5 Shekhar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sesame</td>
<td></td>
</tr>
<tr>
<td>Rewa (Madhya Pradesh)</td>
<td>10 days</td>
<td>Soybean</td>
<td>JS 20-29 Asha</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pigeonpea</td>
<td></td>
</tr>
<tr>
<td>SK Nagar (Gujarat)</td>
<td>31 days</td>
<td>Pearl millet</td>
<td>GHB 558 GG2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cluster bean</td>
<td></td>
</tr>
<tr>
<td>Vijayapura (Karnataka)</td>
<td>28 days</td>
<td>Pearl millet</td>
<td>ICTP- 8203 (ICMV-211)</td>
</tr>
</tbody>
</table>

*Images: Rice var. IR 92521-7-5, Sesame var. Shekhar, Pearl millet var. ICTP- 8203 (ICMV-211)*
Short duration drought tolerant crop varieties suitable for late sowings

<table>
<thead>
<tr>
<th>Crop</th>
<th>Varieties</th>
<th>Avg. Yield (q/ha) (Demo)</th>
<th>Avg. Yield (q/ha) (FP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackgram</td>
<td>PU-35, Shekhar, Pusa Vishal, CO-6, Samrat, Azad Urd-1</td>
<td>8.82</td>
<td>6.32</td>
</tr>
<tr>
<td>Greengram</td>
<td>PDM-139, VBN-3, BM-2003-2, Pratap</td>
<td>9.12</td>
<td>7.28</td>
</tr>
<tr>
<td>Groundnut</td>
<td>TG 37A, TG 38, ICGV-91114, JGN-23</td>
<td>11.77</td>
<td>9.91</td>
</tr>
<tr>
<td>Pigeonpea</td>
<td>TJT-501, ICPL-88039, BRG-2, BRG-4,</td>
<td>11.50</td>
<td>8.63</td>
</tr>
</tbody>
</table>

Scope for scaling up: MP, Jharkhand, UP, TN, Gujarat, Karnataka, Bihar, Chhattisgarh
Community paddy nursery as a contingency measure for delayed planting

Staggered community nursery raised under assured irrigation at an interval of 2 weeks

✔ First nursery raised by 15th June with long duration variety (>140 days) to transplant 3-4 weeks old seedlings by first fortnight of July

✔ If delay / deficit conditions prevail for 4 weeks, second nursery is raised with medium duration varieties (125-135 days) by 1st July to transplant in the 3rd-4th week of July
Direct Seeded Rice for delayed planting & promoting water use efficiency

<table>
<thead>
<tr>
<th>Technology</th>
<th>Input cost (Rs/ha)</th>
<th>Av. Yield (q/ha)</th>
<th>BC Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Seeding Seed @ 30 kg/ha</td>
<td>14100/-</td>
<td>45.0</td>
<td>2.19</td>
</tr>
<tr>
<td>Conventional method (60-80 kg/ha)</td>
<td>18900/-</td>
<td>47.0</td>
<td>1.85</td>
</tr>
</tbody>
</table>

- Timely sowing
- Water saving (25%)
- Diesel saving for pumping (27%)
- Labor saving (35-40 mandays)
- Early maturity (7-10 days) for timely *rabi* cropping
- Low methane emissions / less GWP
- Enhances system productivity

Scope for upscaling
North-west IGP, Bihar, Jharkhand, Odisha, AP, Chattisgarh
Adoption of Resilient Intercropping Systems

Problem: Low productivity and income of crops due to erratic rainfall

<table>
<thead>
<tr>
<th>Crop</th>
<th>KVK</th>
<th>FP (q/ha)</th>
<th>IP (q/ha)</th>
<th>Yield advantage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundnut + Pigeonpea (4:1)</td>
<td>Gumla</td>
<td>15.2</td>
<td>16.7</td>
<td>9.9</td>
</tr>
<tr>
<td>Maize + Pigeonpea (6:2)</td>
<td>Davanagere</td>
<td>44.5</td>
<td>54.5</td>
<td>22</td>
</tr>
<tr>
<td>Soybean + Pigeonpea (6:2)</td>
<td>Amravati</td>
<td>18.0</td>
<td>21.5</td>
<td>64</td>
</tr>
<tr>
<td>Soybean + Pigeonpea (4:2)</td>
<td>Aurangabad</td>
<td>12.0</td>
<td>16.0</td>
<td>33</td>
</tr>
<tr>
<td>Cotton + Greengram (1:1)</td>
<td>Aurangabad</td>
<td>15.5</td>
<td>19.4</td>
<td>25</td>
</tr>
<tr>
<td>Cotton + Blackgram (1:1)</td>
<td>Aurangabad</td>
<td>15.5</td>
<td>17.7</td>
<td>14</td>
</tr>
<tr>
<td>Sateria + Pigeonpea (5:1)</td>
<td>Kurnool</td>
<td>21.0</td>
<td>24.4</td>
<td>16</td>
</tr>
</tbody>
</table>
In situ moisture conservation is the key intervention to mitigate early season drought

In deep black soils of Vidarbha and Marathwada, Maharashtra, opening conservation furrow at 35 DAS of soybean and cotton, enhances yield up to 21%.

In black soils of North Gujarat, with ridge and furrow system, the RWUE (kg/ha-mm) and bean yield in castor was 1.55 and 13.8 q/ha as compared to flatbed system (1.13 & 8.6 q/ha, respectively).

In medium deep black soils of Chhattisgarh, with furrow opening in upland rice at 25 days after sowing, the crop yield was 22.3 q/ha compared to 18.5 q/ha in farmers’ practice.
## Midseason/ Terminal drought : Foliar Sprays

<table>
<thead>
<tr>
<th>AICRPDA Centre</th>
<th>Crop</th>
<th>Treatment</th>
<th>Yield (kg/ha)</th>
<th>Net returns (Rs/ha)</th>
<th>RWUE (kg/ha-mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SK Nagar</strong>&lt;br&gt;Soils: Sandy/sandy loam&lt;br&gt;(RF Deficit 83 % in Aug &amp; 74 % in Sep)</td>
<td><strong>Pearlmillet</strong></td>
<td>Thiourea @ 1000 ppm Urea at 1%</td>
<td>530 475</td>
<td>4387 3408</td>
<td>0.61 0.48</td>
</tr>
<tr>
<td><strong>Indore</strong>&lt;br&gt;(Deep black)&lt;br&gt;(RF Deficit 45% in Sep)</td>
<td><strong>Soybean</strong></td>
<td>Thiourea @ 1% KCl @ 2% KNO₃ @ 1%</td>
<td>333 306 327</td>
<td>- -</td>
<td>0.66 0.61 0.65</td>
</tr>
<tr>
<td><strong>Parbhani</strong>&lt;br&gt;(Deep black)&lt;br&gt;(RF Deficit 36 % in Aug)</td>
<td><strong>Maize</strong></td>
<td>KNO₃ @ 2% Kaoline @ 7%</td>
<td>582 544</td>
<td>8534 7028</td>
<td>1.65 1.53</td>
</tr>
<tr>
<td><strong>Arjia</strong>&lt;br&gt;(Medium deep black)&lt;br&gt;(RF Deficit 36% in Aug &amp; 80% in Sep)</td>
<td><strong>Maize</strong></td>
<td>Thiourea @ 0.5%</td>
<td>1851</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NICRA Village (District/State)</td>
<td>Dry spells</td>
<td>Intervention</td>
<td>Yield (kg/ha)</td>
<td>Net income (Rs/ha)</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------</td>
<td>--------------</td>
<td>---------------</td>
<td>--------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Chianki</strong> (Lakhimpur/Assam) (Loamy soil)</td>
<td>23 days (17 Dec -9 Jan)</td>
<td><strong>Supplemental irrigation (tuber formation) in potato</strong></td>
<td>16970 (88%)</td>
<td>96425</td>
<td></td>
</tr>
<tr>
<td><strong>Terha Saraya</strong> (Mirzapur /Uttar Pradesh) (Loamy soils)</td>
<td>31 days (19 Aug – 21 Sep) and 34 days (23 Sep – 27 Oct)</td>
<td><strong>Supplemental irrigation (panicle initiation) in rice</strong></td>
<td>2450 (Rainfed crop failed)</td>
<td>18800</td>
<td></td>
</tr>
<tr>
<td><strong>Kochariya</strong> (Bhilwara/Rajasthan) (Medium deep black)</td>
<td>12 days (30 July to 10 Aug) and 40 days (15 Aug till harvest)</td>
<td><strong>Supplemental irrigation at silking/floweing stage in maize + blackgram intercropping (2:2)</strong></td>
<td>1330 (52%)</td>
<td>34,134</td>
<td></td>
</tr>
<tr>
<td><strong>Babulgaon</strong> (Parbhani/Maharashtra)</td>
<td>43 days (19 Sep -31 Oct)</td>
<td><strong>Foliar spray of KNO₃ @ 2% in cotton</strong></td>
<td>804 (13%)</td>
<td>11168</td>
<td></td>
</tr>
</tbody>
</table>
Zero till wheat to cope with terminal heat stress

<table>
<thead>
<tr>
<th>Crop</th>
<th>Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology demonstrated</td>
<td>Sowing with zero tillage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yield q/ha</th>
<th>Demo</th>
<th>40.45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers Practice</td>
<td></td>
<td>32.87</td>
</tr>
<tr>
<td>% yield increase</td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>B:C ratio</td>
<td></td>
<td>2.71 (1.67)</td>
</tr>
</tbody>
</table>

**Impact:**
- Saves irrigation water up to 10-15% during 1st irrigation
- Early sowing in late condition
- Uniform seed germination
- 25% less seed rate (save 2 ploughings)
- Low weed population
- Increased grain yield by 23% with 2.71 B:C ratio
Broad bed furrow protects soybean during excess rainfall in Madhya Pradesh

<table>
<thead>
<tr>
<th>Particular</th>
<th>Broad bed and Furrow</th>
<th>Farmers Practice</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain Yield (kg/ha)</td>
<td>1937</td>
<td>1152</td>
<td>40.5</td>
</tr>
<tr>
<td>Net Return (Rs/ha)</td>
<td>38805</td>
<td>18898</td>
<td>51.3</td>
</tr>
<tr>
<td>B:C Ratio</td>
<td>3.51</td>
<td>2.41</td>
<td></td>
</tr>
<tr>
<td>Rain Water Use Efficiency (kg/ha-mm)</td>
<td>2.09</td>
<td>1.24</td>
<td></td>
</tr>
</tbody>
</table>

Making of BBFs

Drainage in furrows

Crop stand in BBF
Zero tillage minimizes the yield loss due to intense rains

- Zero till (ZT) sowing minimizes losses due to lodging of wheat.
- ZT gave higher yields by 14 q/ha over conventional tillage.
- Higher returns by up to Rs.21,000/ha.
- Severe loss (in about 20% of area) in wheat yields because of lodging due to unseasonal rains in March 2016.
- Adoption of ZT would have reduced the loss and increased the production by one million tonne in Punjab (Rs.1525 crores).

Wheat yields during 2015-16 at Ropar

- Conventional tillage
  - Yields (q/ha): 33.7
- Zero tillage
  - Yields (q/ha): 48.5
# Adoption of Flood Tolerant Paddy varieties in Flood prone areas

- Identified performing varieties in low, medium and high inundation areas
- Submergence tolerance for 7-10 days
- Increased yield due to reduced lodging
- Prevented loss in grain and straw yield

<table>
<thead>
<tr>
<th>Tolerant paddy cultivars</th>
<th>Yield (q/ha)</th>
<th>% increase in yield</th>
<th>B: C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Demo</td>
<td>Local</td>
<td></td>
</tr>
<tr>
<td>Swarna Sub-1</td>
<td>41.25</td>
<td>33.75</td>
<td>18.9</td>
</tr>
<tr>
<td>MTU-1061</td>
<td>45.28</td>
<td>28.1</td>
<td>23.1</td>
</tr>
<tr>
<td>MTU-1140</td>
<td>55.1</td>
<td>31.8</td>
<td>73.2</td>
</tr>
<tr>
<td>Jalashree</td>
<td>30.4</td>
<td>27.0</td>
<td>12.5</td>
</tr>
<tr>
<td>Karjat-6</td>
<td>38.0</td>
<td>31.6</td>
<td>20.2</td>
</tr>
<tr>
<td>RGL-2537</td>
<td>53.9</td>
<td>45.0</td>
<td>19.8</td>
</tr>
</tbody>
</table>

Scope for scaling up: Assam, AP, Odisha, West Bengal, MH
## Performance of flood tolerant varieties of paddy

<table>
<thead>
<tr>
<th>Flooding and submergence</th>
<th>Variety</th>
<th>Location</th>
<th>No. of farmers</th>
<th>Increase in yield over FP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water level &lt;1 m and submergence &lt;10 days</td>
<td>Swarna sub-1, Dishang, Joymoti, MTU-1010, MTU-1100, MTU-1064, MTU-1140, MTU-7029, BPT-5204, Dehangi, Gitesh, Shasharang</td>
<td>Kushinagar, Saran, Gorakhpur, Maharajgunj, Baharaich, Gonda, West Godavari, Srikakulam, Kendrapara, Jharsuguda, Buxar, Jehanabad, Villururam</td>
<td>1071</td>
<td>30-35</td>
</tr>
<tr>
<td>Water level &gt;1 m and submergence &gt;10 days</td>
<td>Jalashree, Jalkuwari, Rajashree, Karjat-2, Karjat-6, GAR-13, Lalat, Luit</td>
<td>Dhubri, Cachar, Sonitpur, Dibrugarh, Kushinagar, Kendrapara</td>
<td>208</td>
<td>20-25</td>
</tr>
</tbody>
</table>

Srinivasarao et al. (2016)
## Improved breeds introduced in different villages

<table>
<thead>
<tr>
<th>District</th>
<th>Improved breed</th>
<th>No. of animals/ birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cachar, Dibrugarh</td>
<td>Kalinga Brown (poultry), Vanjara (poultry)</td>
<td>1000</td>
</tr>
<tr>
<td>Dimapur</td>
<td>Vanaraja and Gramapriya (poultry)</td>
<td>200</td>
</tr>
<tr>
<td>East Sikkim</td>
<td>Vanaraja (poultry)</td>
<td>140</td>
</tr>
<tr>
<td>Lunglei</td>
<td>Vanaraja (poultry)</td>
<td>10</td>
</tr>
<tr>
<td>Anantapur</td>
<td>Rajasree (poultry)</td>
<td>35</td>
</tr>
<tr>
<td>Khammam, Nalgonda</td>
<td>Vanajara (poultry)</td>
<td>30</td>
</tr>
<tr>
<td>Balaghat</td>
<td>Kadaknath (poultry)</td>
<td>100</td>
</tr>
<tr>
<td>Kendrapara, Sonitpur</td>
<td>Vanaraja and Blackrock (poultry)</td>
<td>1215</td>
</tr>
<tr>
<td>Ganjam</td>
<td>Rainbow Rooster (poultry)</td>
<td>100</td>
</tr>
<tr>
<td>Jhansi</td>
<td>Chabro (poultry)</td>
<td>400</td>
</tr>
<tr>
<td>Ri-Bhoi</td>
<td>Vanaraja (poultry), Assam hill goat and Hampshire cross (pig)</td>
<td>48</td>
</tr>
<tr>
<td>Senapati</td>
<td>Gramapriya (poultry) and Hampshire cross (pig)</td>
<td>300</td>
</tr>
<tr>
<td>West Kameng</td>
<td>Ghungroo, Hampshire cross, Duric,</td>
<td>17</td>
</tr>
<tr>
<td>Gumla, Chatra</td>
<td>Beetal buck (goat)</td>
<td>21</td>
</tr>
<tr>
<td>Coochbehar</td>
<td>Khaki campbel (duck), Vanjara (poultry)</td>
<td>46</td>
</tr>
<tr>
<td>Chitrakoot</td>
<td>Latitpuri (goat)</td>
<td>52</td>
</tr>
<tr>
<td>Gorakhpur</td>
<td>Barbary (goat)</td>
<td>5</td>
</tr>
<tr>
<td>Ahmednagar, Aurangabad</td>
<td>Sirohi (goat), Girija (poultry)</td>
<td>60</td>
</tr>
<tr>
<td>Datia, Satna</td>
<td>Murrah (buffalo), Jamunapari &amp; Latitpuri (goat)</td>
<td>30</td>
</tr>
<tr>
<td>Tikamgarh</td>
<td>Jamunapari (goat)</td>
<td>5</td>
</tr>
<tr>
<td>Jharsuguda</td>
<td>Black Bengal (goat)</td>
<td>40</td>
</tr>
<tr>
<td>Namakkal</td>
<td>Rams of NARI Swarna (sheep), Telicherry (goat)</td>
<td>2</td>
</tr>
<tr>
<td>Jodhpur</td>
<td>Tharparkar (bullock)</td>
<td>82</td>
</tr>
</tbody>
</table>
Integrated Farming Systems (IFS) models for household food, livelihood and ecological sustainability

- Field crops
- Horticulture
- Livestock
- Fish/poultry/duckery
- Other on farm livelihoods
- Compost/vermi compost
- Farm ponds
- Rainfed systems
- Household food security
- Household nutrition society
- Ecological sustainability
- Livelihood security
- High rainfall systems

Srinivasarao et al. (2016)
Expansion strategy of climate resilient villages in India

Srinivasarao et al. (2016)
District level contingency plans cover contingency strategies to be taken up by farmers in response to major weather-related aberrations such as delay in onset and breaks in monsoon causing early, mid, and late season droughts, floods, unusual rainfall, storms, cyclones, frost, heat wave, cold wave, hailstorm, and cyclone. Read More

### Contingency Preparedness

**Stakeholders to Cope Deficient Rainfall - 2015**

- CRIDA-Central Level
- Maharashtra
- MP
- Karnataka
- Andhra Pradesh
- Telangana
- Chhattisgarh
- Rajasthan
- Gujarat
- Jharkhand
- Uttar Pradesh
- Haryana

[www.crida.in:82/contingency_planning/](http://www.crida.in:82/contingency_planning/)
623-District Agriculture Contingency Plans

- 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/AICRPA M network)
  - Villages (through KVKs under NICRA-TDC)

- Able to reach State Action Plans - NMSA
- District-Mandal-Village Level Implementation
- 2014: 9% Sowing area reduction offset
- Large scale land treatments implemented
- 2015: 12 State Interface Meetings
- 2016: 11 State Interface Meetings
The District Contingency Plans cover

- Delay in monsoon onset
- Breaks in monsoon leading to early, mid and late-season droughts
- Delayed or limited release of water for irrigation
- Floods, Unseasonal rains
- Extreme weather events: Heat wave, Cold wave, Frost, Hailstorm, Cyclone

Suggested contingency measures:

- Change in variety, crop
- Appropriate Agronomic measures
- Implementation, linkage issues, sources of seed/ inputs, etc

Contingency measures in 5 key Agricultural crops / Horticulture, Livestock, Poultry, Fisheries sectors
Status of District Agriculture Contingency Plans

(Total= 623)
Post Rainy Season (Rabi) Action Plan to Utilize Residual Moisture or Off-Season Rainfall
For further information:
www.crida.in
http://www.nicra-icar.in/nicrarevised/