Climate Change and Food Security in Asia

Suhas P Wani and AVR Kesava Rao
The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is an international non-profit organization that undertakes scientific research for development.

We believe all people have a right to nutritious food and a better livelihood.

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<th>VISION</th>
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<td>A prosperous, food-secure and resilient dryland tropics</td>
<td>To reduce poverty, hunger, malnutrition and environmental degradation in the dryland tropics</td>
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Through demand-driven innovation, we dare to do it!

VALUES
- Inclusive culture
- “We” not “me”
- Leadership by example — inspiring yourself & others
- Strategic & systems thinking to change, grow & improve
Challenges of the 21st Century

- Climate change
- Water scarcity
- Land degradation
- Loss of biodiversity
- Poverty, malnutrition, Food security
- Low agricultural growth
- Low W&N use efficiency
- Low incomes

5177 m³
1545 m³
120 m ha affected
Rainfed Agriculture

- Contributes 60% of world’s food from 80% of cultivated land
- Home of world’s poor and malnourished people
- Yields from rainfed agriculture are low in Semi-Arid Tropical Agroecosystems
- Green Revolution in India drove away food shortage of 1960’s, but at a cost
Rainfed Agriculture has the Potential

- 80% of global agriculture is rainfed (1.2 B ha)
- Current farmers’ yields are lower by 2 to 5 times achievable yields
- Vast potential of rainfed agriculture needs to be harnessed
Global CO₂ Trends

Carbon dioxide — the gas that is most responsible for global warming; reached a significant symbolic milestone in our atmosphere.
WMO confirms 2016 as hottest year on record, about 1.1°C above pre-industrial era.
Steady Increase in Temperature in India

Annual Average Temperature of India: 1901-2016

Source: IMD, 2017
Steady Increase in High-rainfall Events in India

- Significant rising trends in the frequency and the magnitude of extreme rain events
- Significant decreasing trend in the frequency of moderate events
- Contribution from increasing heavy events is offset by decreasing moderate events
- Substantial increase in hazards related to heavy rain is expected over Central India in the future

Source: Goswami et al., 2006
Major Extreme Weather Events Occurred During 2016

- Four cyclonic storms and six depressions
- Severe heat waves over central and peninsular parts of the country during April & May
- Phalodi in Rajasthan recorded highest-ever temperature of 51°C on 19th May
- Heavy rain & flood related incidents from different parts of the country during the monsoon season

Source: IMD, 2017
Changes in Climate Types in India

- Increase in arid areas in Rajasthan and Gujarat
- Increase in semi-arid areas in MP, Bihar and UP
- Net reduction of 10.71 m ha in the dry sub-humid areas

Dryness and wetness are increasing in different parts of the country in the place of moderate climates existing earlier in these regions

Source: AVR Kesava Rao et al., 2013
Projected percentage change in yields of 11 major crops (wheat, rice, maize, millet, field pea, sugar beet, sweet potato, soybean, groundnut, sunflower, and rapeseed)

From 2046 to 2055, compared with 1996–2005

Average of three emission scenarios across five global climate models, assuming no CO$_2$ fertilization

Large negative yield impacts are projected in many areas that are highly dependent on agriculture

Source: Müller and others 2009
Impacts of Projected Climate on Pigeonpea at Kalaburagi and Groundnut at Patancheru, India

- Increase in temperature by 2 °C reduces crop duration by 9 days without changing plant water use
- Increase in temperature by 2 °C reduces crop yields by 16% and TDM by 9%
- Increase in temp by 2 °C coupled with decrease in rainfall by 20% may cause the yield reduction of 28%

<table>
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<th>CC Scenario</th>
<th>Seed yield (kg ha⁻¹)</th>
<th>Seed yield (%)</th>
<th>Total DMP (kg ha⁻¹)</th>
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<tbody>
<tr>
<td>Current</td>
<td>2000</td>
<td>-</td>
<td>5430</td>
</tr>
<tr>
<td>HadGEM2-ES</td>
<td>1820</td>
<td>-9</td>
<td>5410</td>
</tr>
<tr>
<td>GFDL-CM3</td>
<td>1830</td>
<td>-9</td>
<td>5350</td>
</tr>
<tr>
<td>CNRM-CM5</td>
<td>1750</td>
<td>-13</td>
<td>5250</td>
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Climate Change: ICRISAT’s Hypothesis of Hope
Agro-biodiversity - Vital in the Global Fight against Hunger and Poverty

- Biological diversity is the foundation for agricultural research for food security

- The ICRISAT Genebank is considered as a treasure trove of genetically-diverse types of its five focus crops (pearl millet, sorghum, chickpea, pigeonpea and groundnut)
  - Has more than 120,000 germplasm accessions from 144 countries
  - Responsible for conserving and evaluating the germplasm
ICRISAT’s Climate smart food crops - Advantages

- Climate smart food crops; able to produce more Nutrition per Drop
- High water use efficiency; can be grown under rainfed and on residual soil moisture
- Thrive well under harsh environments; can survive over 40°C
- Legumes improve soil fertility
- Availability of extra-early and drought tolerant cultivars and hybrids to adapt to climate change and having resistance to new / emerging diseases and pests
- Diverse uses – Food, fodder / feed
- Availability of bio-fortified varieties (iron and zinc) resulting in nutritional and health benefits
- Highly nutritious and multiple culinary uses
- Expanding markets and diversified products
Pearl Millet flowering at >40°C

Pioneer hybrid 86 M 64 in Gujarat
Climate Smart Crop Cultivars: Super-early Chickpeas

- Super early ICC 96029, 75-80 days
- Extra-early ICCV 2, 85-90 days
- Early maturing KAK 2, 90-95 days

Effects of high temperatures on pod set in chickpea

Sensitive

Tolerant
Chickpea Revolution in Andhra Pradesh, India

During the past decade:

- 4-fold increase in area
- 2.4-fold increase in yield
- 9-fold increase in production
- Over 80% area under improved cultivars
- Crops or cultivars alone cannot ensure food and nutrition security
- Sustainable natural resources management is must
Farmer-centric Holistic Watershed as an Entry Point for Sustainable Livelihood Improvement

- IGNRM, holistic livelihood approach
- Science-based consortium approach
- Profitability and sustainability
- Empowerment and knowledge sharing
- Social inclusion (equity, gender and youth)
In-situ Moisture Conservation to Enhance Green Water Availability

- Contour cultivation
- Broad Bed and Furrow
- Cultivation across the slope
- Border strips, Field bunds
- Conservation agriculture / minimum tillage
- Mulching
Community-based Rainwater Harvesting/ Groundwater Recharging

- Check dams
- Percolation tanks
- Gabion structures
- Grassed waterways
- Diversion drains
Water Alone Can’t Do It

- Soil health
- Climate-smart crops and cultivars
- Pests and disease management
- Markets, institutions and policy support
- Need for integrated approach
Innovative Extension Systems
Scaling-up of Technologies for Impact: Bhoochetana in Karnataka

- Increased crop yields by 20–66%
- Covered 5.0 m ha and benefitted 4.75 m farmers
- Contributed to rise in agriculture growth annually above 5% since 2009
- Benefit cost ratio for the farmers 3-14:1
- Net benefits accrued in 5 years Rs. 1963 Crores (US$ 353 million)
Primary Sector Mission in AP – Rythu Kosam

18% Growth rate
Rs. 1,69,552 Crores

18% Growth rate
Rs. 1,43,498 Crores

- The AP Govt and ICRISAT heralded a new beginning for smallholder farmers
- Technical backstopping at pilot sites in 13 districts of 10,000 ha each
**Groundnut Crop Sowing Advisories**

Devanakonda Mandal, Kurnool District

- Sowing at right time is critical in rainfed agriculture
- Large variability exists at Devanakonda in rainfed crop-sowing date
- Presently no advisory is available to farmers on right sowing period
- ICRISAT, Microsoft, aWhere, CYA (NGO) joined hands
- 175 farmers registered their mobiles for receiving advisories through SMS
Way Forward for Future Food Security

- Small farms operated by both men and women will play a big role in feeding the world in future; relevant management practices to be developed and promoted
- Assisting women farmers is an effective way to reduce poverty and enhance food security
- Sustainably enhancing annual output from pasture lands per hectare
- Encouraging nutritious and healthy diets and discouraging excessive food consumption
- Diet diversification will reduce the water footprint of present-day foods
- Integrated approaches to be followed for sustainable food future
ICRISAT’s Holistic Approach to the Agricultural R4D Value Chain

Analyzing key problems and opportunities
Managing soil and water
Crop Improvement & seed Access
Integrating Social Dimension

Diversifying Farms
Developing on-farm practices and technologies
Introducing processing
Facilitating market access
Driving market development

Building Agribusinesses

Cross-cutting issues
- Mainstreaming nutrition
- Empowering women – women are consulted, involved and supported to lead
- Attracting youth to agriculture

Approach for Adoption
- Participatory approach and partnering – working side by side
- Building capacity – at a national and local level
- Integrating communications - to build awareness and share knowledge
- Monitoring and evaluation – for feedback and adjustment
- Policy support – work closely with government to encourage the needed policies
Five Steps to Solve the World’s Food Dilemma*

1. Freeze carbon footprint of agriculture at the current level or reduce
2. Grow more on existing farms
3. Use resources more efficiently
4. Change diets
5. Reduce post-harvest losses and food wastage

*Thanks to Jonathan Foley and National Geographic
Thank You