# Climate Change and Food Security in Asia

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ICRISAT
INTERNATIONAL CROPS RESEARCH
INSTITUTE FOR THE SEMI-ARID TROPICS

# 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.**

**VISION**
A prosperous, food-secure and resilient dryland tropics

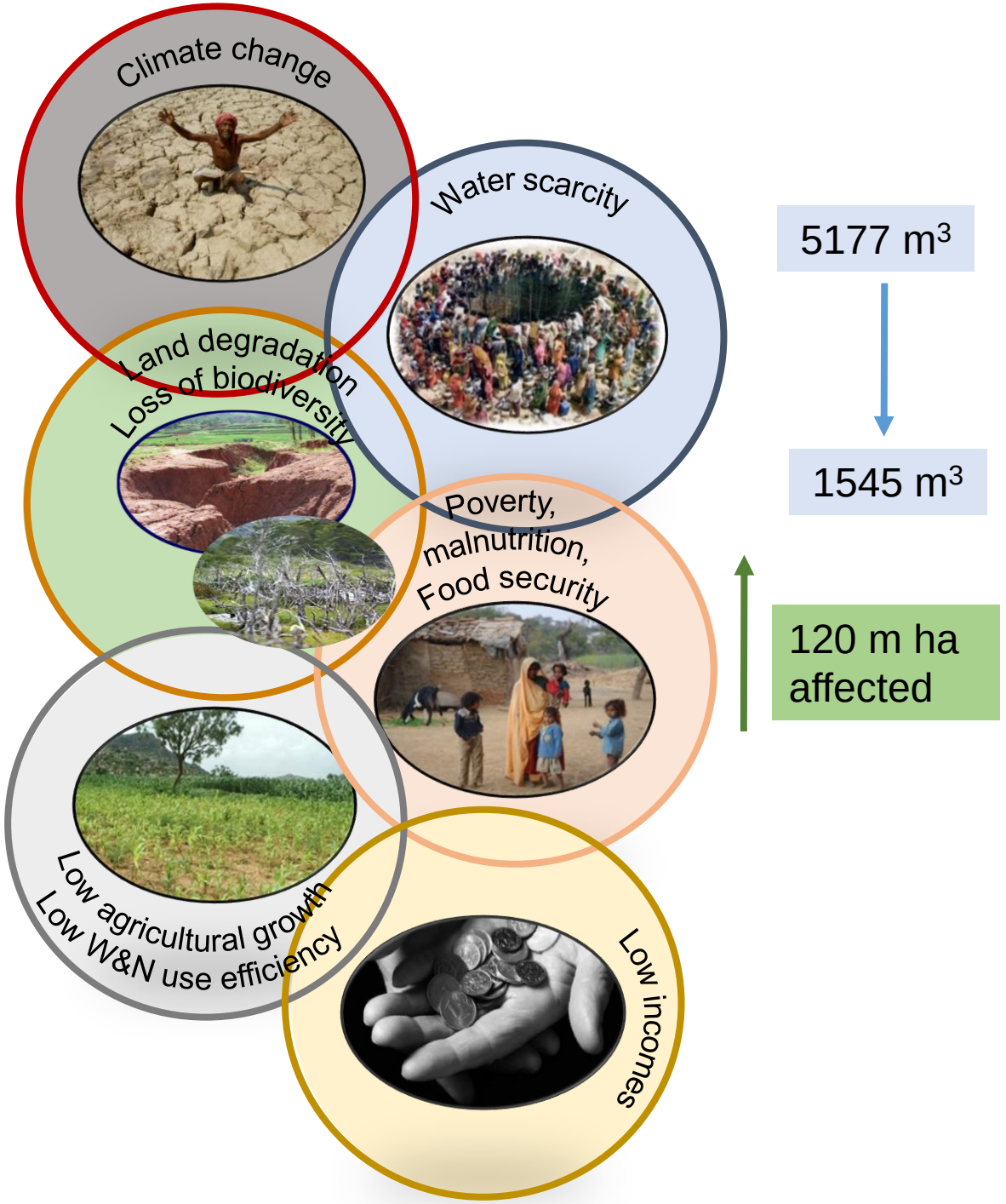
**MISSION**
To reduce poverty, hunger, malnutrition and environmental degradation in the dryland tropics

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

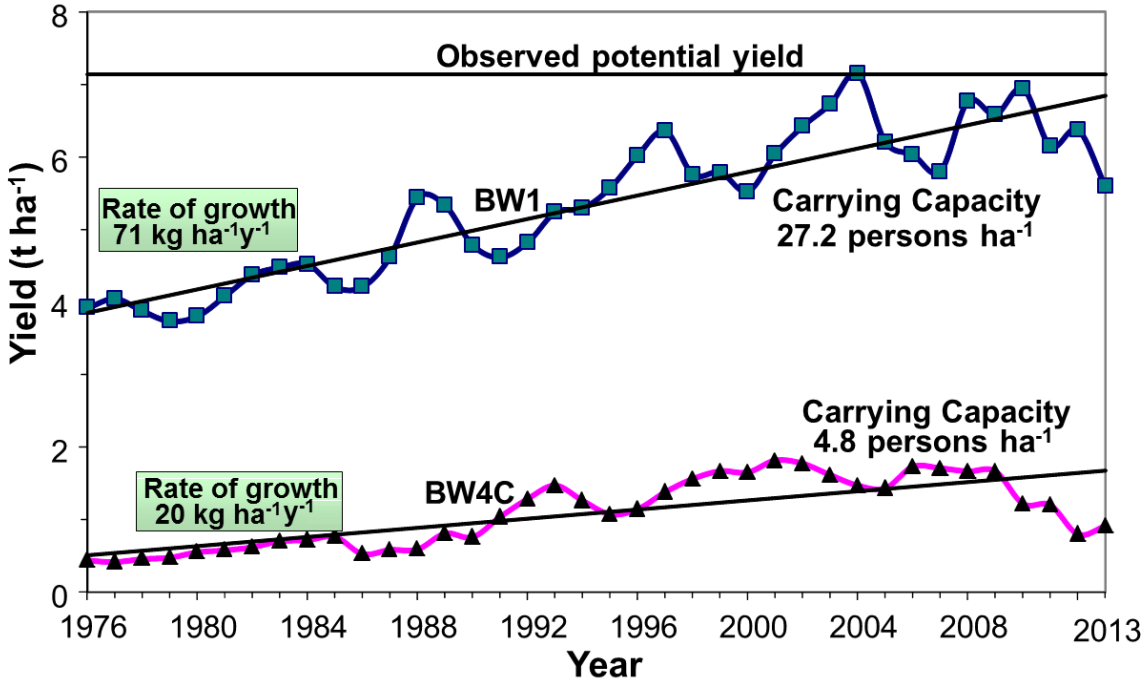


# Rainfed Agriculture

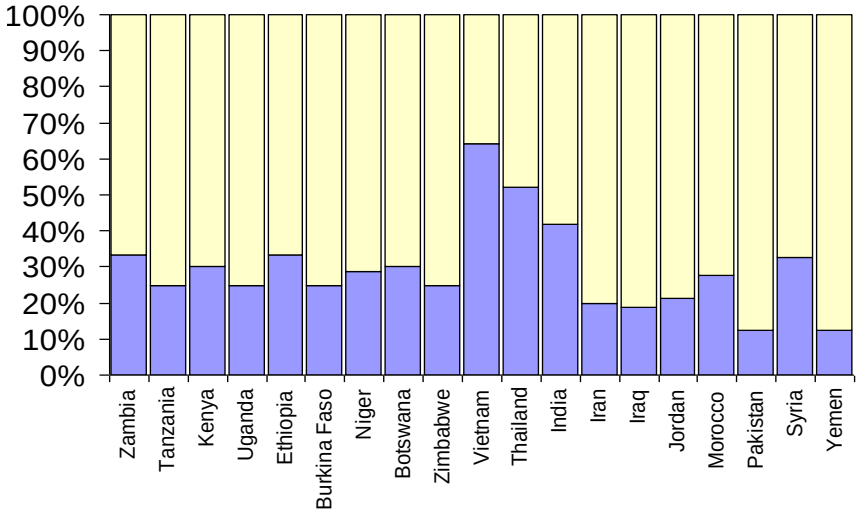
- Contributes 60% of world's food from 80% of cultivated land
- Home of world's poor and malnourished people
- Yields from rainfed agriculture are low in Semi-Arid Tropical Agroecosystems
- Green Revolution in India drove away food shortage of 1960's, but at a cost

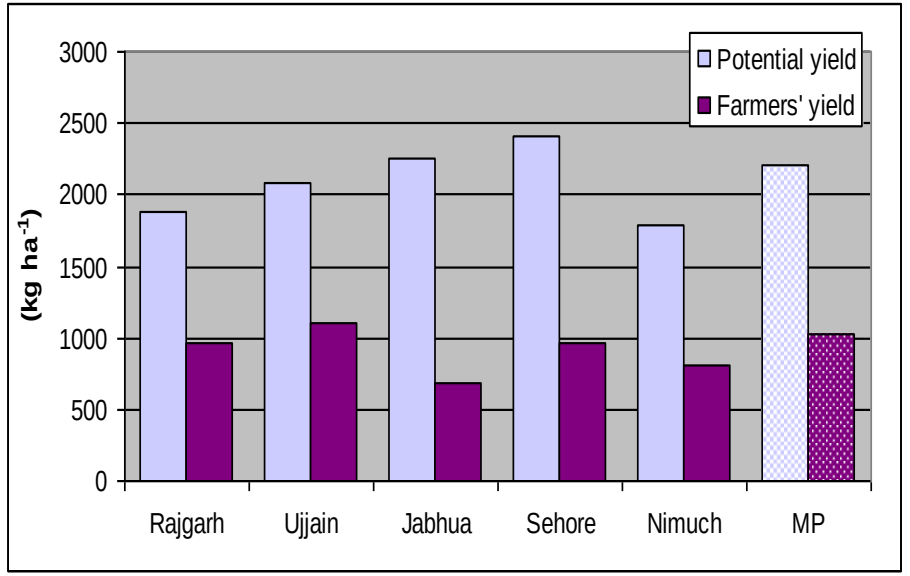
# Rainfed Agriculture has the Potential

- 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




**Observed Yield Gap between Farmers' Yields and Achievable Yields, worldwide**

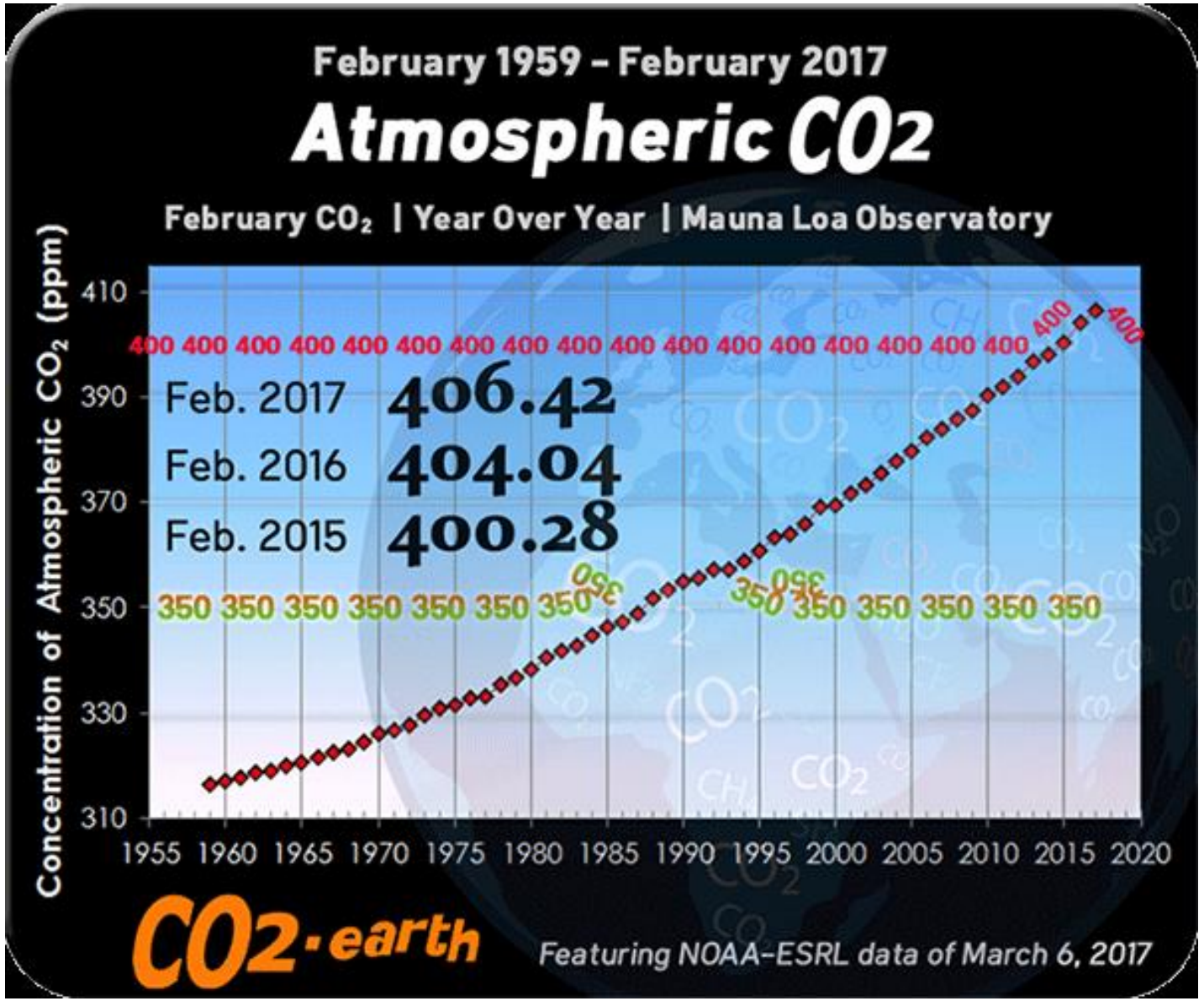



**Yield Gap of Soybean in MP, India**

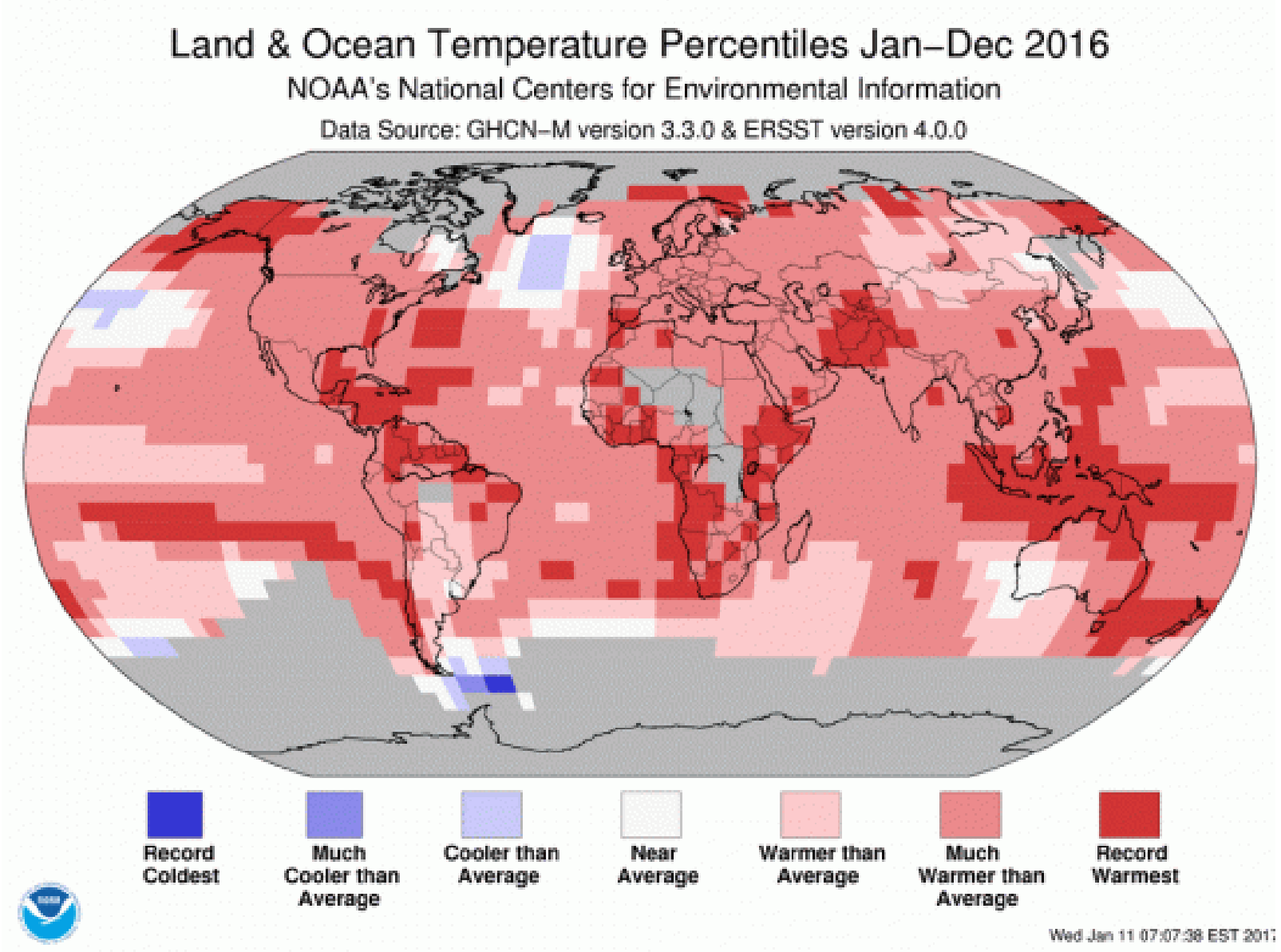
# Global $CO_2$ Trends

Carbon dioxide — the gas that is most responsible for global warming; reached a significant symbolic milestone in our atmosphere



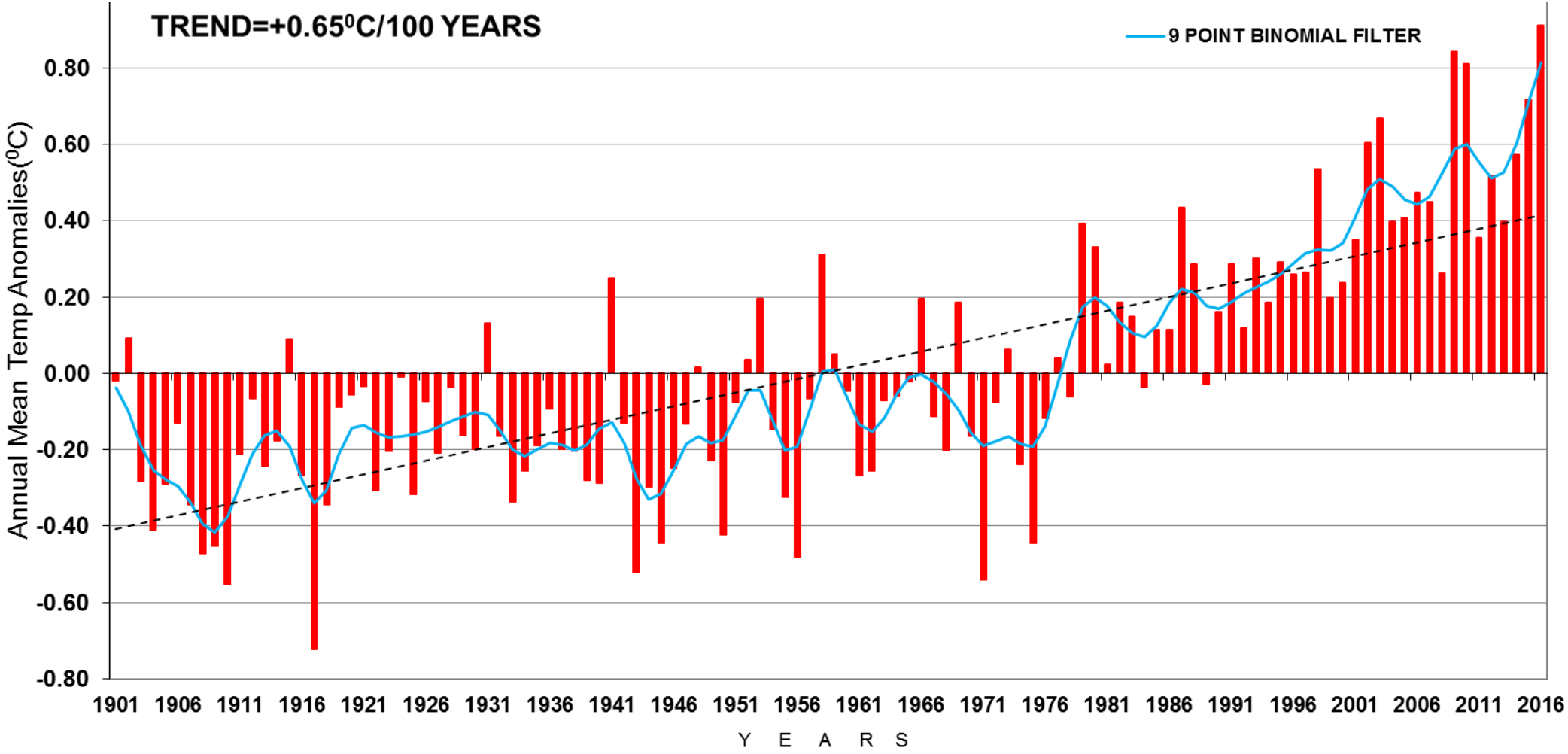
# Warmest Year 2016

WMO confirms 2016 as hottest year on record, about 1.1°C above pre-industrial era



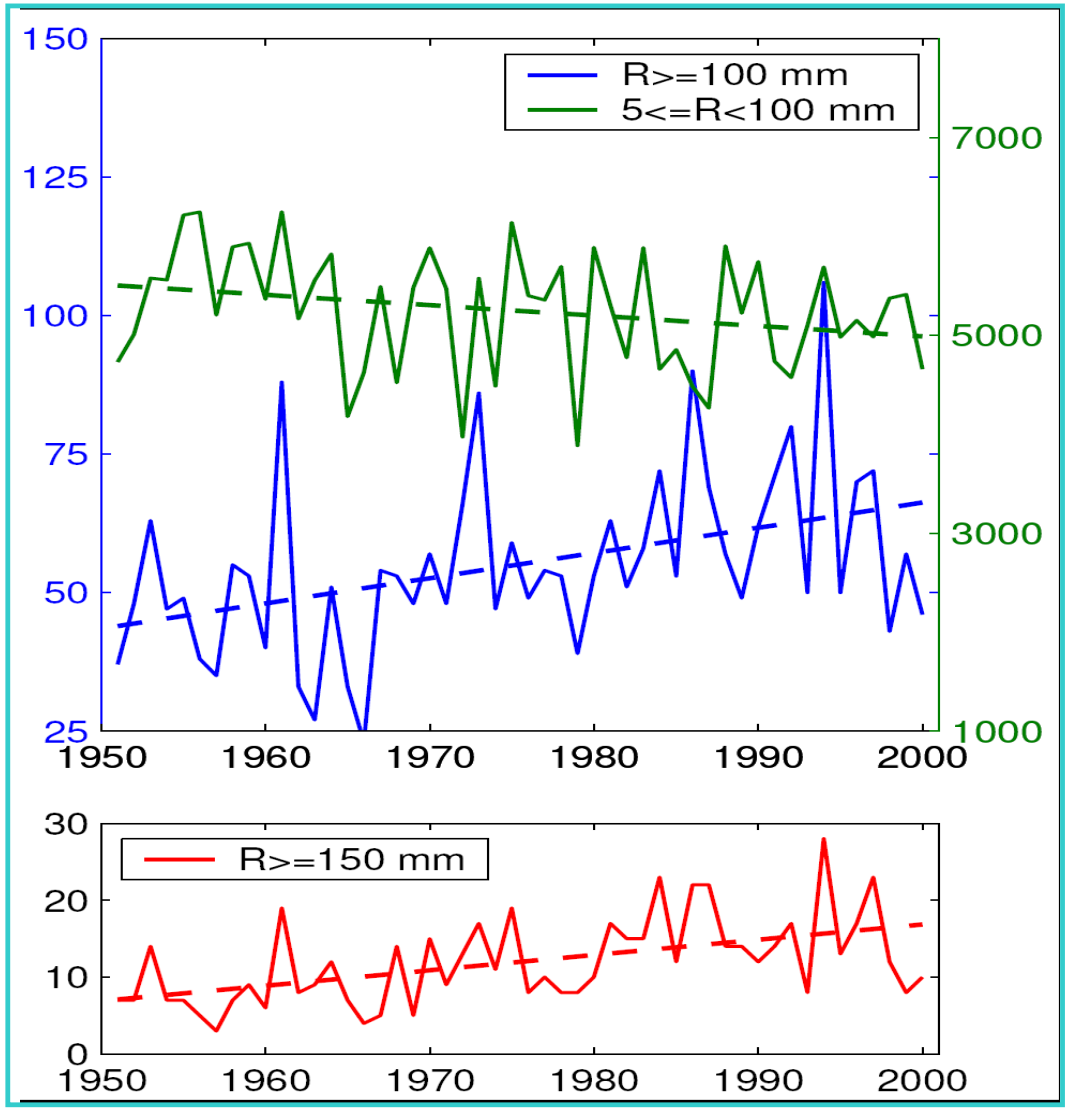
# Steady Increase in Temperature in India

## Annual Average Temperature of India: 1901-2016




*Source: IMD, 2017*

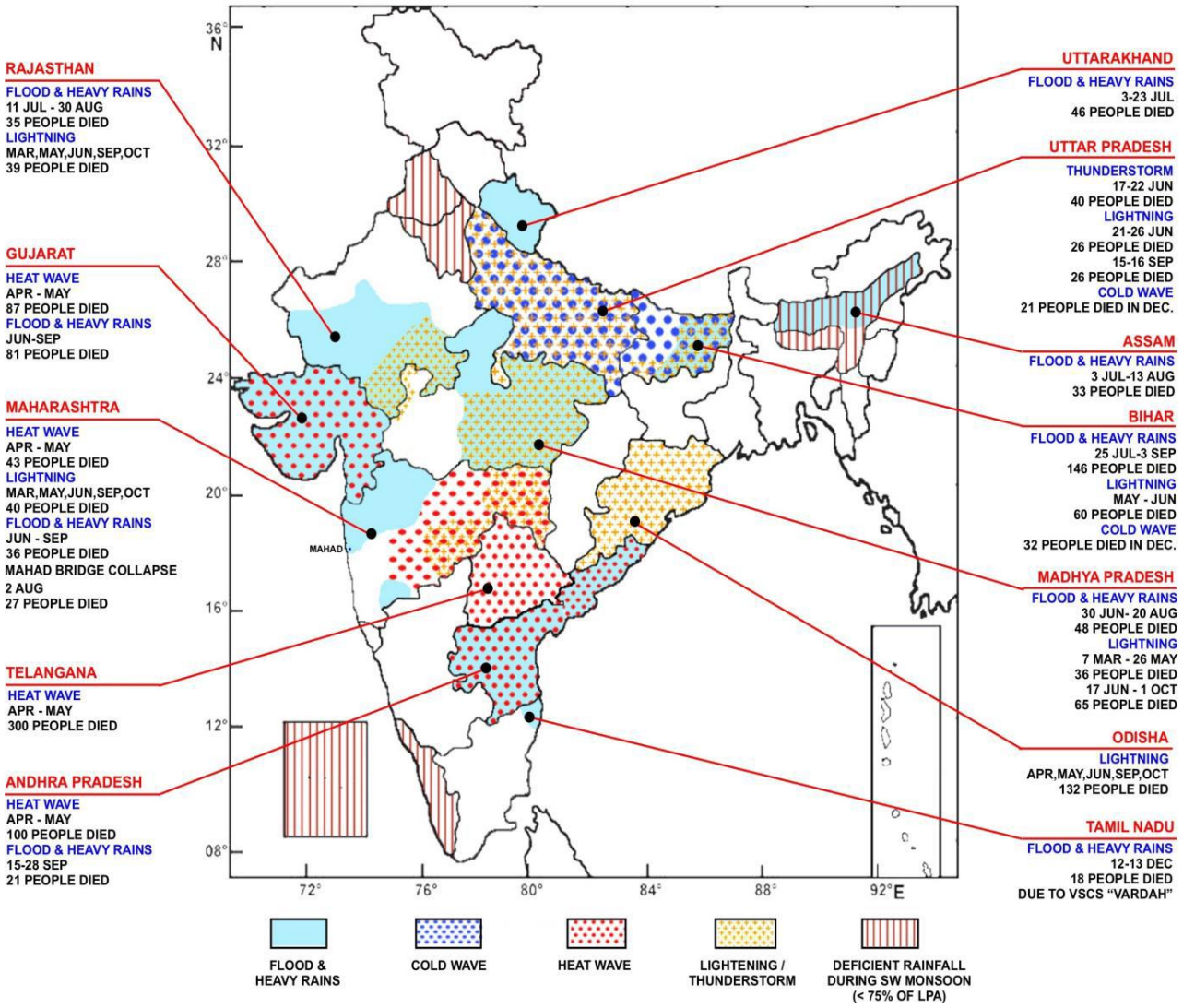
# Steady Increase in High-rainfall Events in India




- 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*

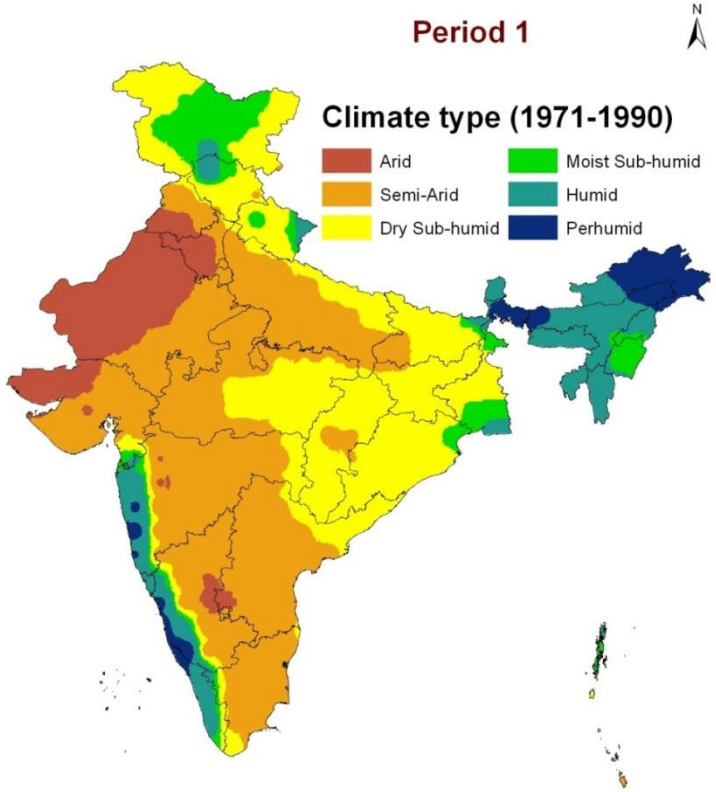
# Major Extreme Weather Events Occurred During 2016



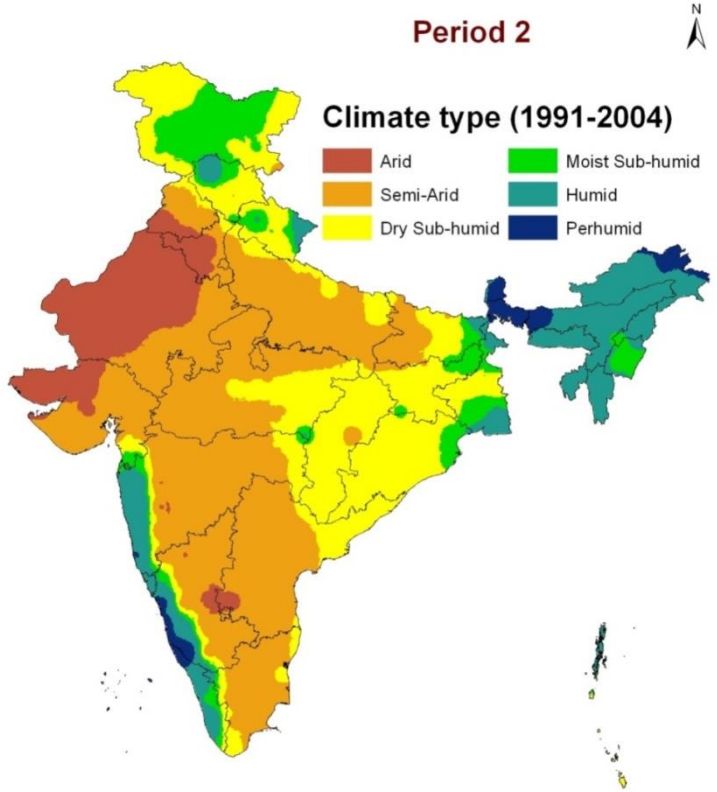

- Four cyclonic storms and six depressions
- Severe heat waves over central and peninsular parts of the country during April & May
- Phalodi in Rajasthan recorded highest-ever temperature of 51°C on 19th May
- Heavy rain & flood related incidents from different parts of the country during the monsoon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

*Source: IMD, 2017*

# Changes in Climate Types in India



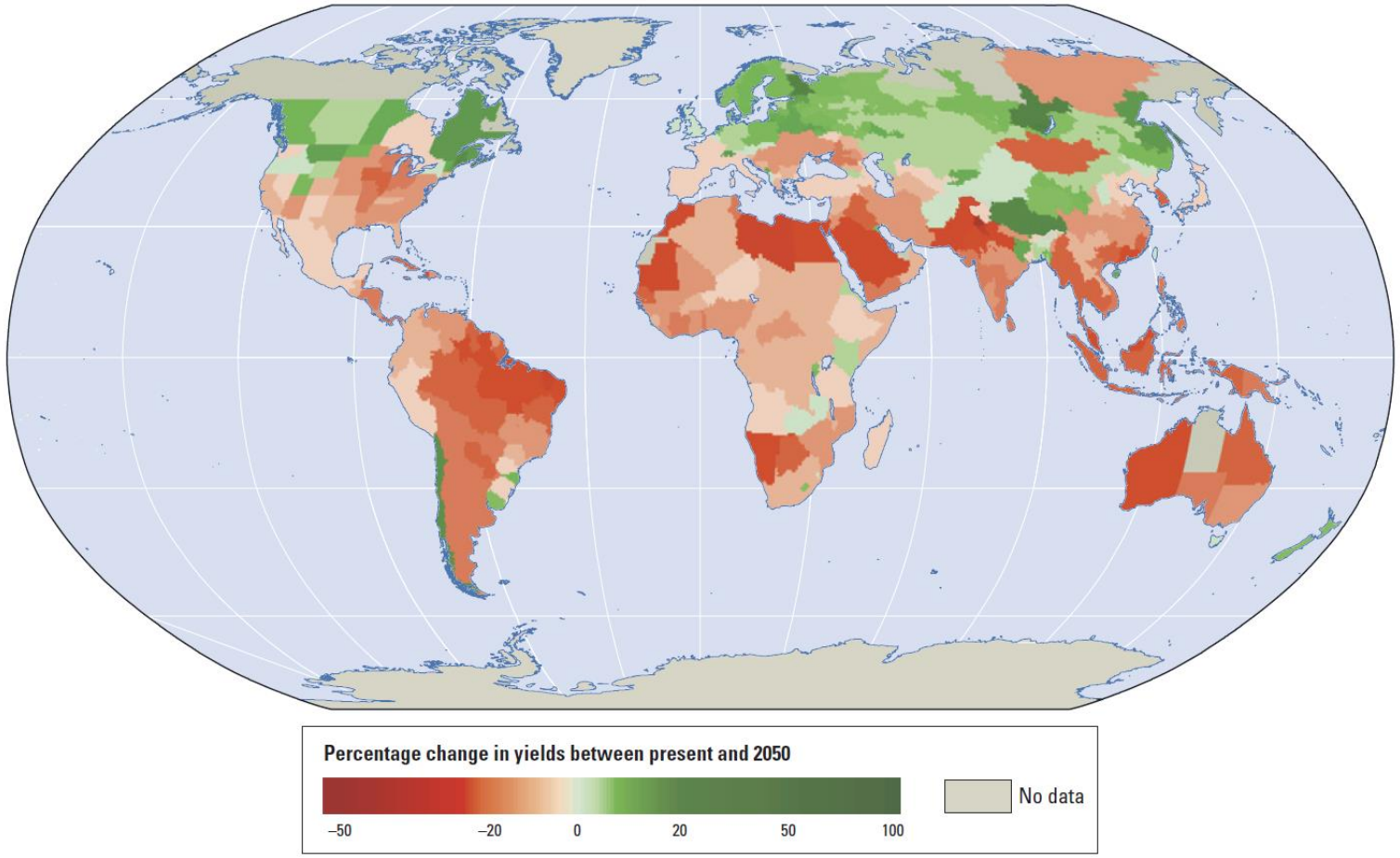

- Increase in arid areas in Rajasthan and Gujarat
- Increase in semi-arid areas in MP, Bihar and UP
- Net reduction of 10.71 m ha in the dry sub-humid areas




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*

# Climate Change Impacts on Agricultural Yields




- 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

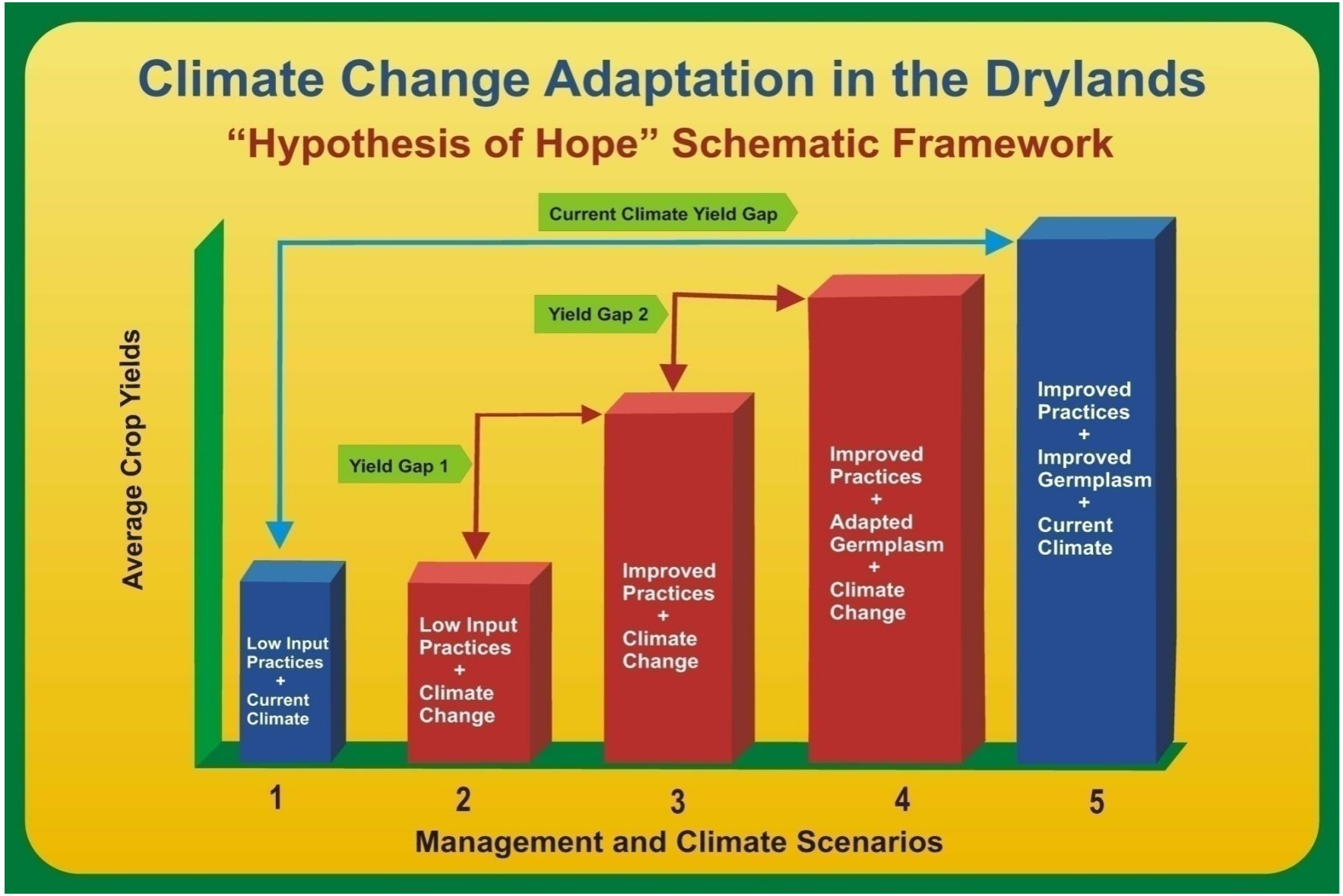
*Source*: Müller and others 2009

# 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%


| CC Scenario | Seed yield (kg ha$^{-1}$) | Seed yield (%) | Total DMP (kg ha$^{-1}$) |
|---|---|---|---|
| Current | 2000 | - | 5430 |
| HadGEM2-ES | 1820 | -9 | 5410 |
| GFDL-CM3 | 1830 | -9 | 5350 |
| CNRM-CM5 | 1750 | -13 | 5250 |

# 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 $40^0$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

# Climate Smart Crop Cultivars: Super-early Chickpeas


Effects of high temperatures on pod set in chickpea

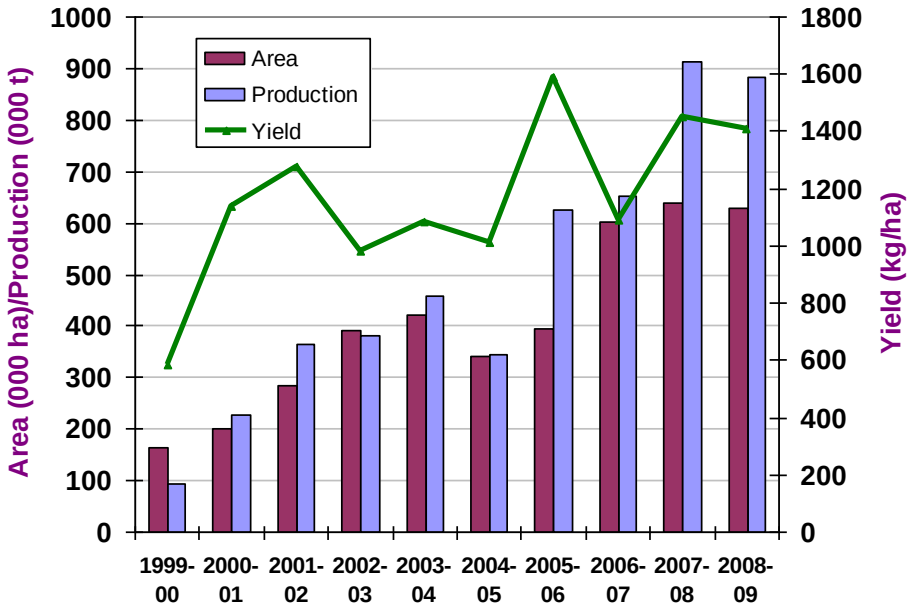
Sensitive

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 can not 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

Conservation furrow system

Chickpea on BBF-furrow

Groundnut on BBF

# Community-based Rainwater Harvesting/ Groundwater Recharging

- Check dams
- Percolation tanks
- Gabion structures
- Grassed waterways
- Diversion drains

Vidisha, MP

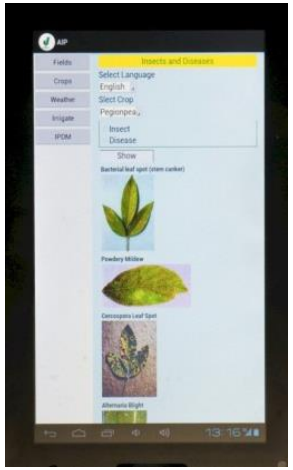
Bundi, Rajasthan

Dewas, MP

# 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

Rs. 1,43,498 Crores

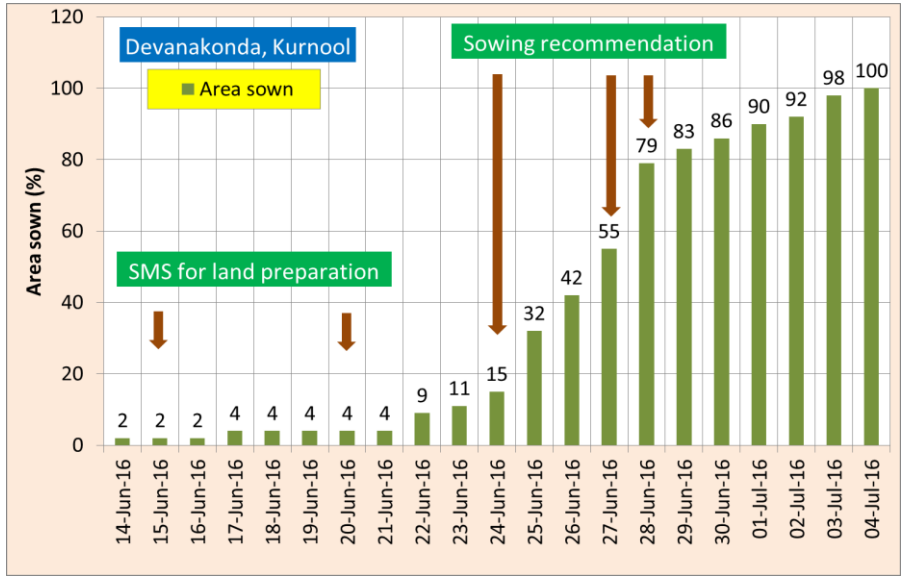
- The AP Govt and ICRISAT heralded a new beginning for smallholder farmers
- Technical backstopping at pilot sites in 13 districts of 10,000 ha each

# Groundnut Crop Sowing Advisories

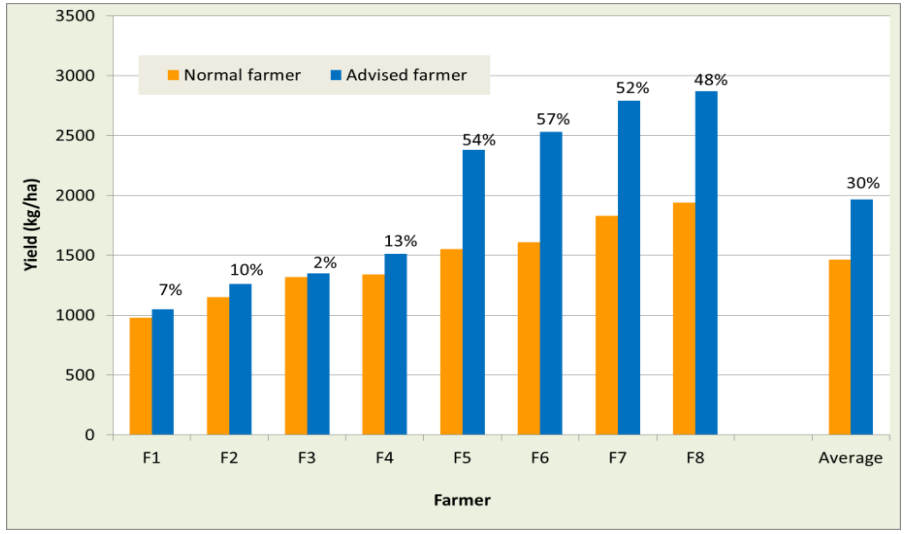
## Devanakonda Mandal, Kurnool District

- 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

Sowing progress




Climate resilient groundnut yields



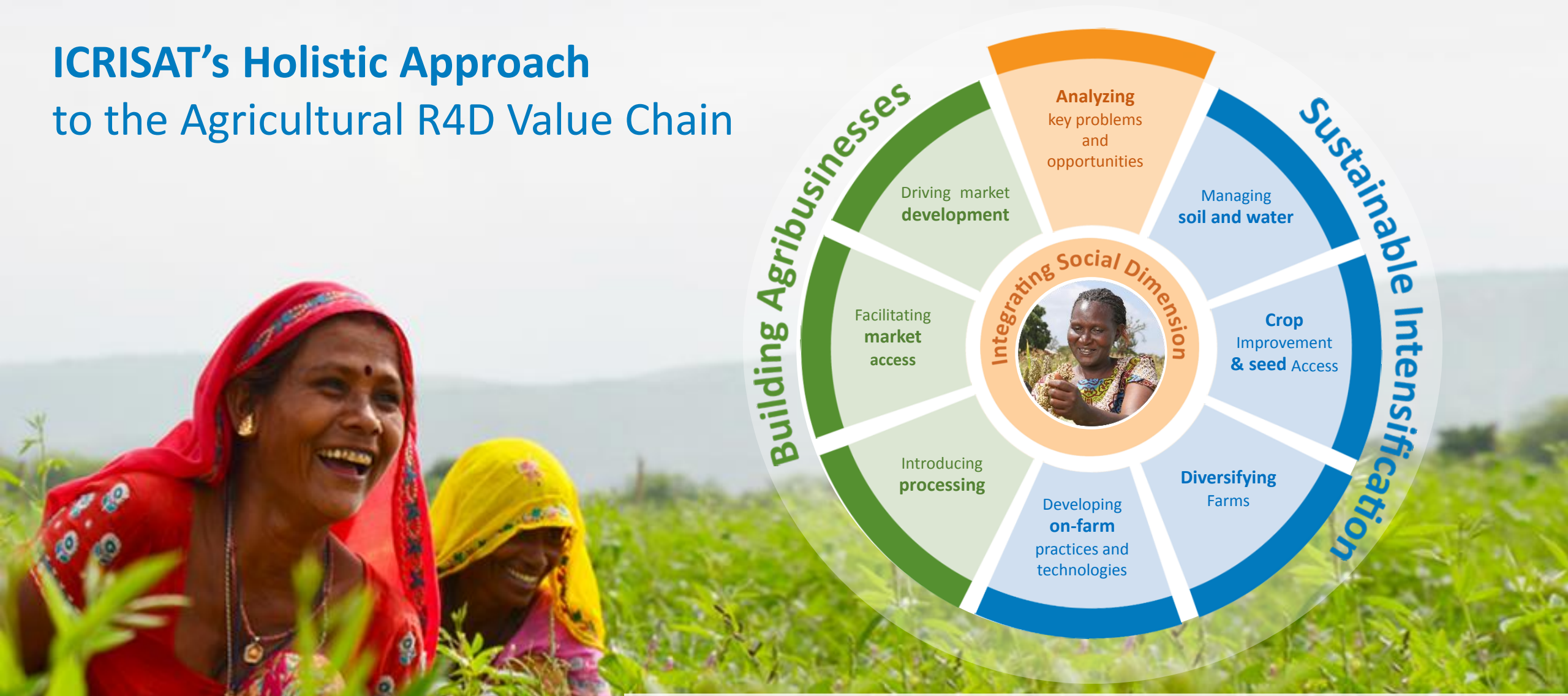
# Way Forward for Future Food Security

- 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




### 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

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