Emerging Challenges For Chickpea Production System Under Current Climatic & Ecological Changes

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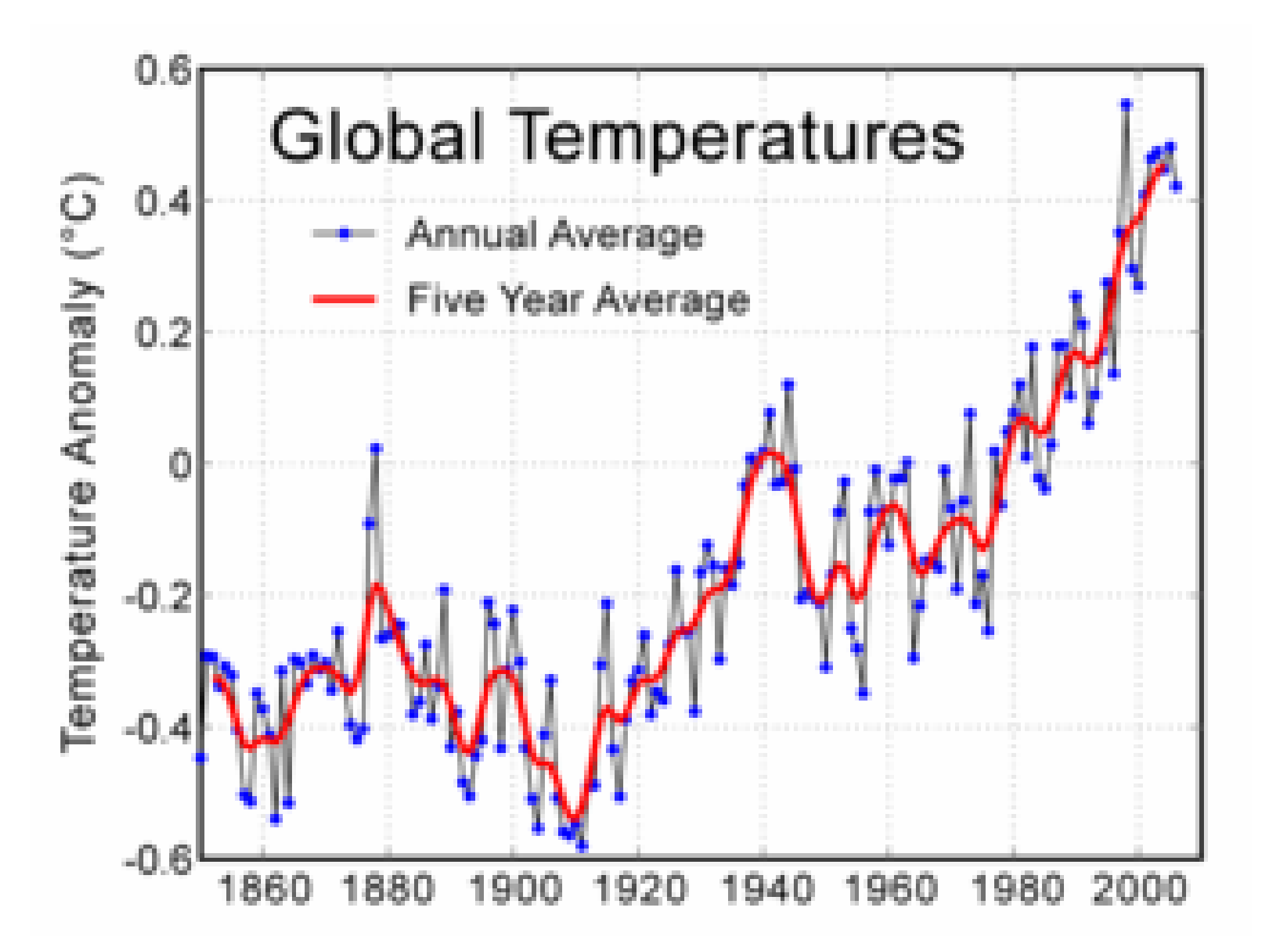
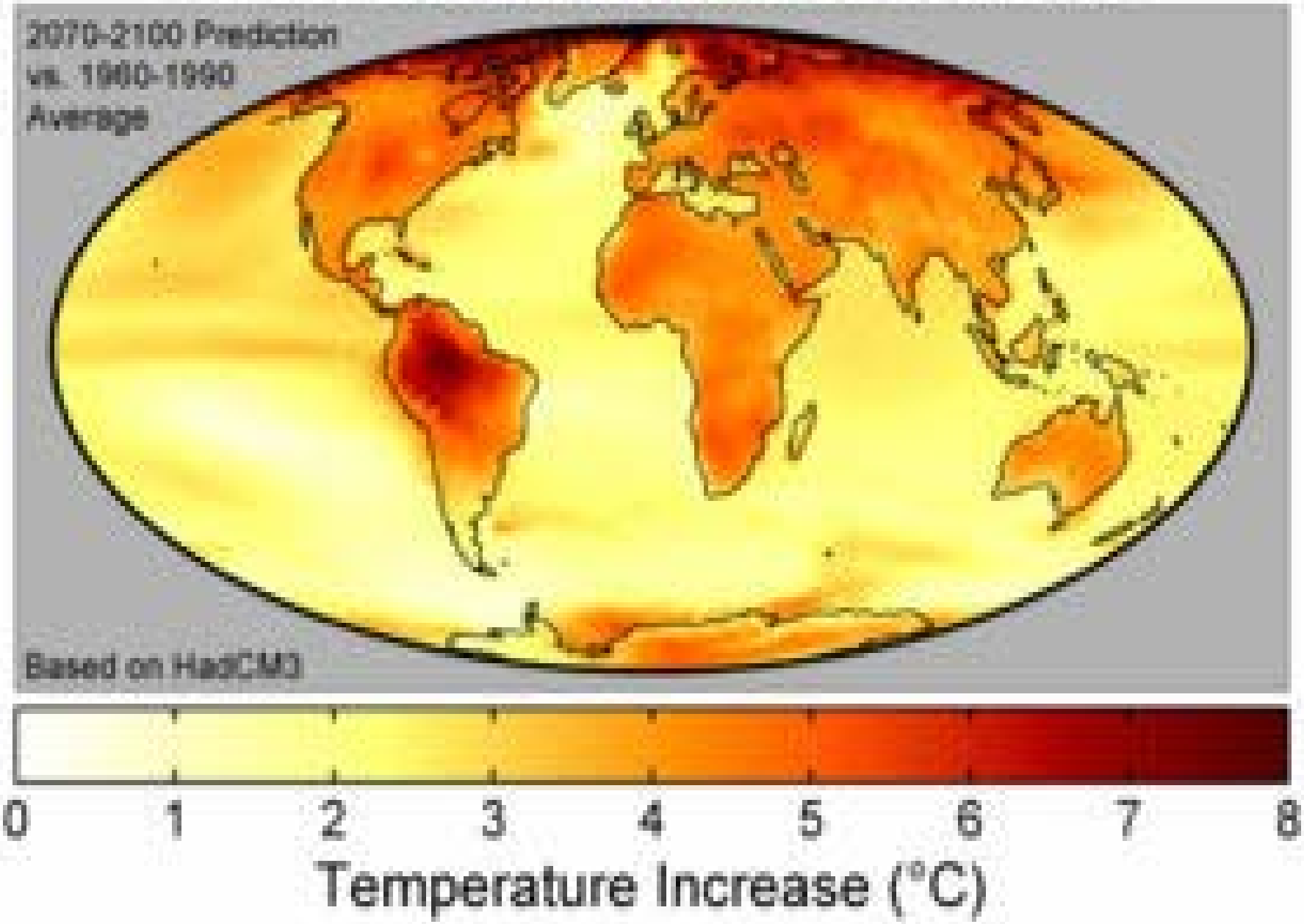
GLOBAL WARMING & CLIMATIC CHANGES IS REALITY NOW

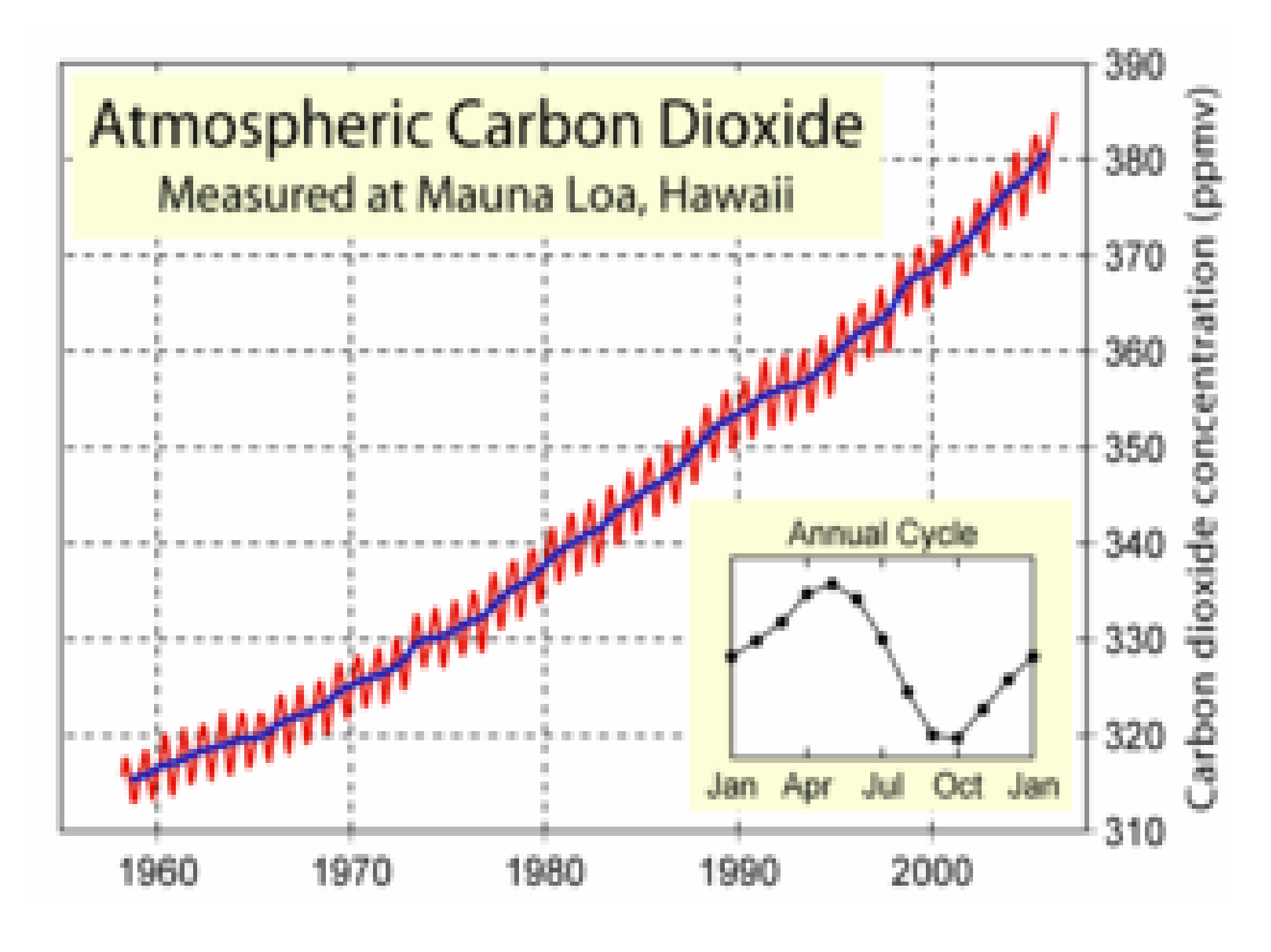
- **Climatic risks associated with global warming**

  Increase in temperatures, hot days, hot nights, and heat waves.
- **Global mean temperatures have increased by 0.74^{o}C during last 100 years.**
- **More droughts and floods**
- **Increasing frequency of heavy precipitation events**
- **Tropical cyclones to become more intense, with heavier precipitation.**


Global Temperatures
Annual Average
Five Year Average
Temperature Anomaly (°C)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
1860
1880
1900
1920
1940
1960
1980
2000

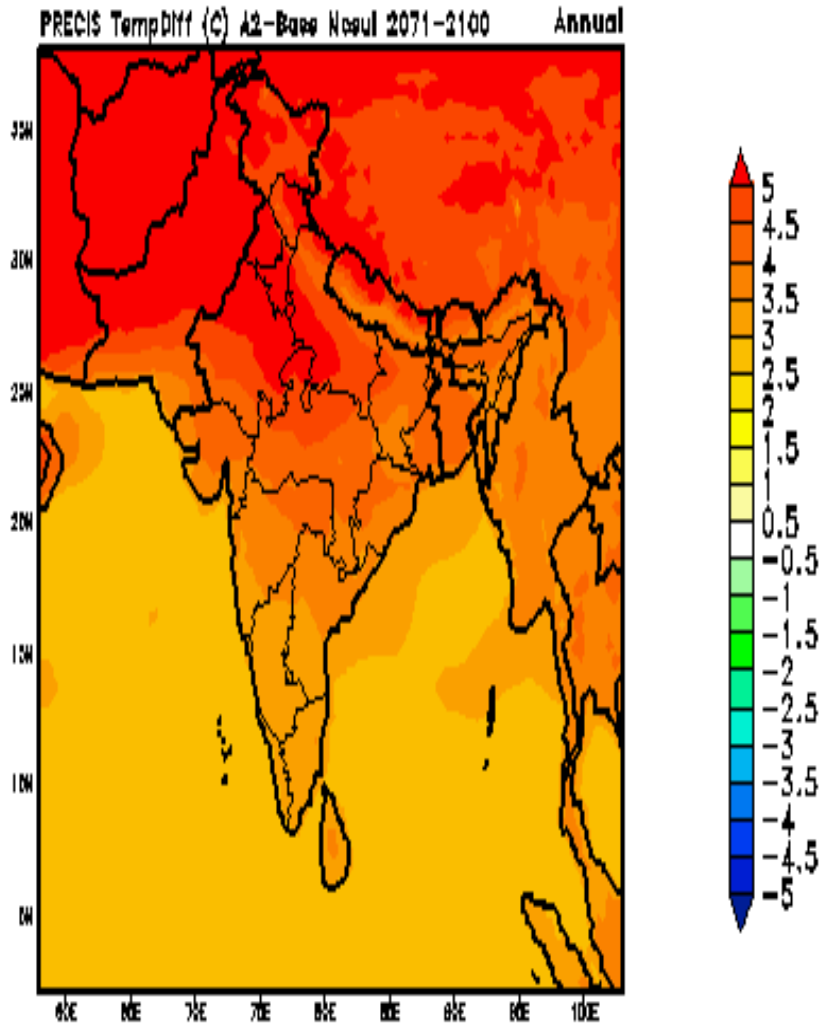
Global Warming Predictions



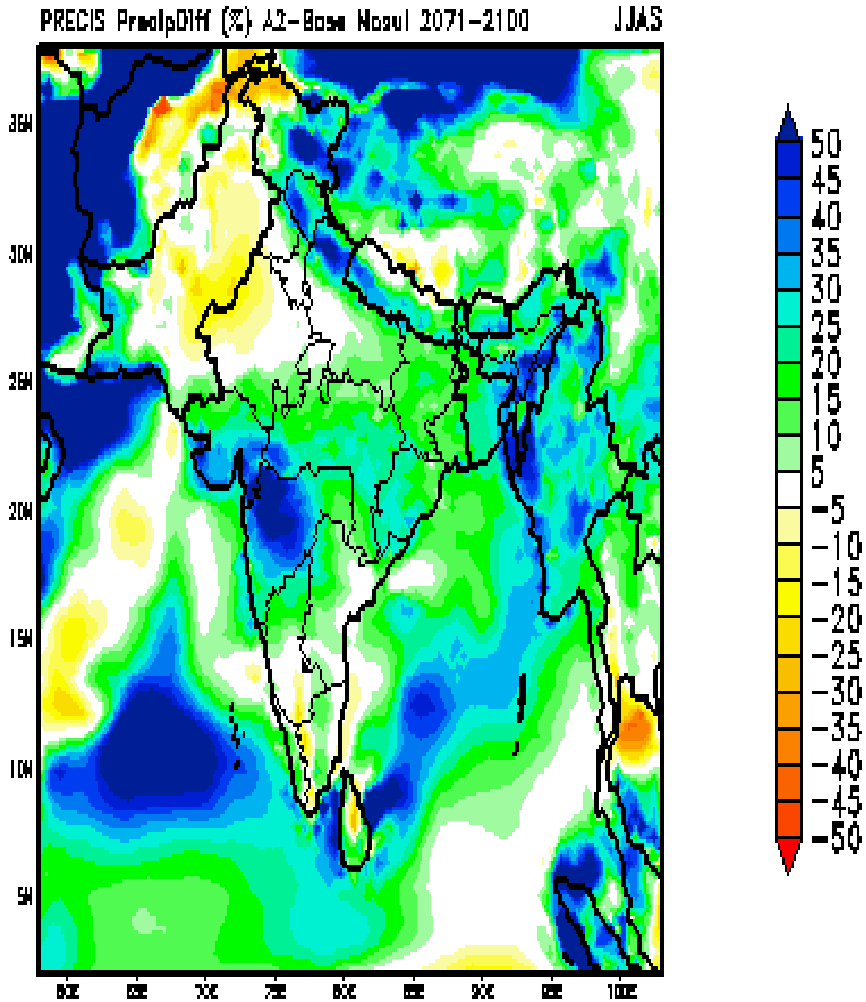

Atmospheric Carbon Dioxide
Measured at Mauna Loa, Hawaii
Annual Cycle
Jan
Apr
Jul
Oct
Jan
1960
1970
1980
1990
2000
310
320
330
340
350
360
370
380
390
Carbon dioxide concentration (ppmv)

Projected Indian Climatic Changes for 2071-2100 relative to baseline (1961-1990)

Temperature



Rain fall



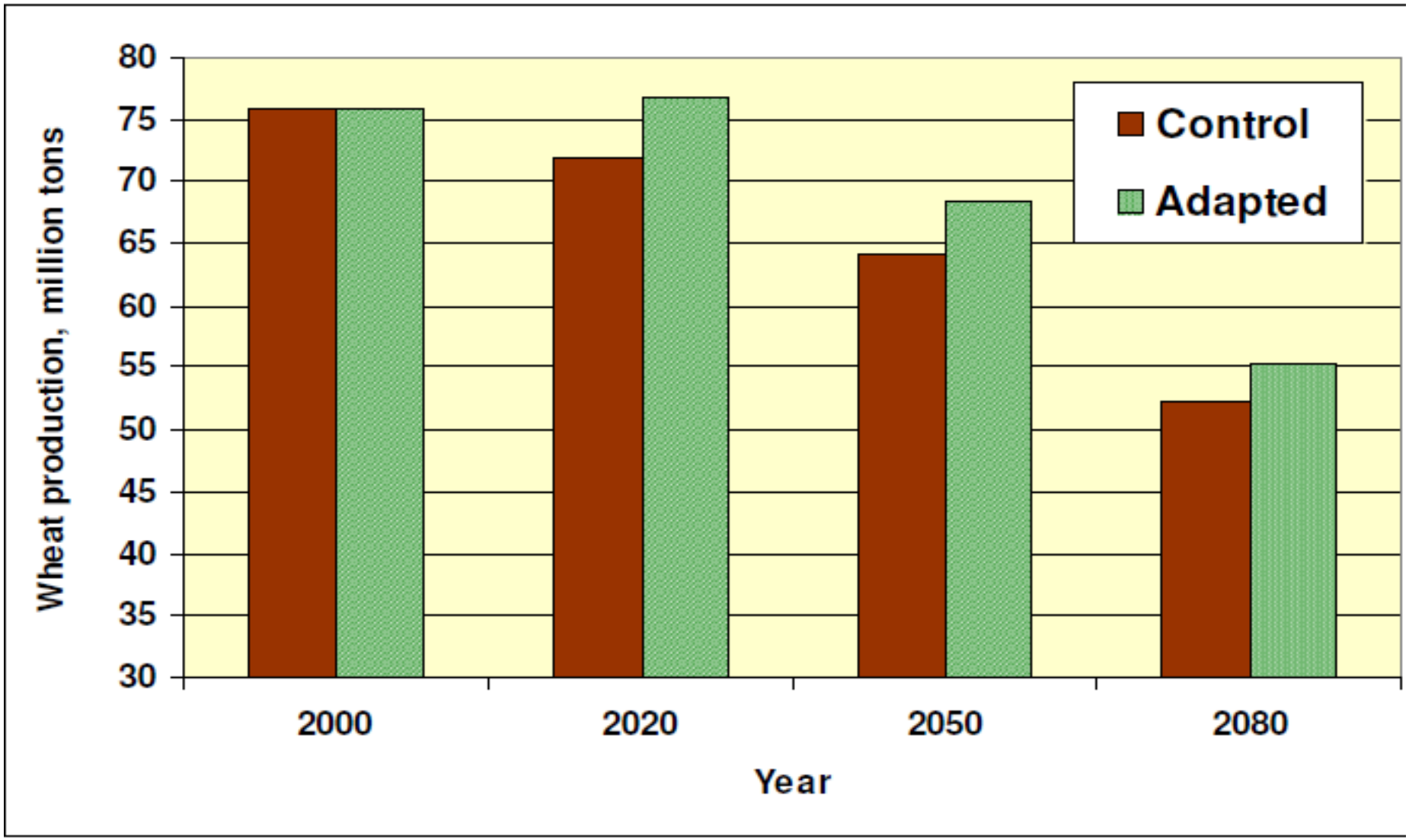
Management for meeting challenges of climatic risks is important

- **Flood** Frequent, especially in eastern India
- **Frost** Common in north-western India
- **Heat** Frequent episodes
- **Cyclones** Frequent in coastal areas
- **Drought** 2/3 land is rainfed
  - » 26 droughts in last 130 years
  - » Irrigation system is climatic (monsoon) dependent

Projected impacts of climate change on Indian agriculture

- Drastically decrease productivity of most crops (10-40%) by 2100.
- Reduce yields of wheat, soybean, mustard etc. due to increase temp.
- Improvement in yields of chickpea, rabi maize, sorghum, millets etc
- Increases yield of some crops by 10-20% due to Increase in CO_2 to 550 ppm

Impact of climate change on wheat



How to adapt agriculture to climate change?

1. **Assist farmers in coping with current climatic risks**
   - -weather services, agro-advisories, insurance, community banks for seed and fodder
2. **Intensify food production systems**
   - -technology and input delivery systems, market links
3. **Improve land and water management**
   - -technologies for resource conservation and use efficiency
4. **Enable policies and regional cooperation**
   - -incentives to farmers for resource conservation and use efficiency, pricing of resources, credit for transition to adaptation technologies
5. **Strengthen research for enhancing adaptive capacity**
   - -varieties, resource conservation technologies, pest surveillance
   - -for improved assessments: mechanism for collection and dissemination of weather, soil, water and agricultural data

Managing climatic variability is critical

But Not IMPOSSIBLE for crop improvement

- **Climatic Changes increased Production variability**

- **MANAGING CLIMATIC VARIABILITY Through CROP IMPROVEMENT TECHNIQUES :-**
  - Suitable crop adjustments & Adopting appropriate technology for the changed environmental conditions
  - Developing proper genotypes with **Matching crop phenology with weather conditions**
  - **Changing varieties / crops / production technology**
  - **Introduction of crops to new ecological conditions**

- **Breeding for Environmental (Abiotic)Stresses:-**
  - **- Variable Temp (thermo-periods), Moisture, photoperiods, Co_{2} etc.**

Development of "Adverse Climate Tolerant' genotypes is final solution for absorbing impact of climatic changes

Proven Effect of Crop Improvement on HI & YIELD

Crop	Variety	Released (Year)	HI (%)	Yield (t/ha)
Peanut	Dixie Runner	1943	23	2.5
	Early Bunch	1973	51	5.5
Pigeonpea	Traditional Tall	-	20	0.7
	Hunt	1983	50	3.0
Soyabean	Dorman	1952	23	1.8
	Essex	1972	50	3.3
Wheat	P68 India	1910	17	2.2
	Arjun,India	1980	46	5.7
Rice	Traditional (Tall)	-	22	2.2
	IR 32(IRRI)	1974	41	5.2

Average yield of various Crops(Kg/ha)

Crop	Asian Region	Developing world	Developed World	Experim-ental
Chickpea	642	663	1031	4000
Pigeonpea	689	684	2222	4210
Cowpea	571	241	-	4200
Mungbean	490	496	1000	2500
Dry beans	429	559	1597	2637
Soyabean	960	1564	2420	5560
Food Legumes	**553**	**610**	**1654**	-
Rice	2441	3106	5520	10000
Wheat	1772	2056	2608	10000
Maize	1430	2120	6692	10000
Total Cereals	**1842**	**2162**	**4378**	-

Where Classical Breeding Systems Inefficient to absorb Impact of climatic changes ?

Then Biotechnological Techniques also Useful

- Transcription factors used naturally for abiotic stress tolerance for Heat ,Cold, Drought, Salinity
- **Drought /Cold have similar Protein Mechanisms**
- Barley ABRC1 promoter / *Arabidopsis* CBF1 transformed tomato for Salinization, Drought and Chilling tolerance
- Sunflower gene HaHSFA9 with DS10 promoter Transformed Tobacco for Heat Stress Tolerance through overexpressed HSPs

GREEN REVOLUTION BECOME REALITY

- **MODIFIED IDEOTYPE** with change phenology, Improve plant architecture with semi dwarf, erect & compact growth habit suitable for high density planting under high inputs conditions
- **Improve stability against abiotic stresses** (moisture, temp, etc.) & biotic (pests/diseases)

- Improved adaptation to different environmental conditions
- Govt. policy support to cereal production

- IDEOTYPE : Model plant that is expected to yield greater quantity and quality of grain or other useful products in a particular environment when developed as cultivar

Metrics of climate change impact on Adaptation of Chickpea

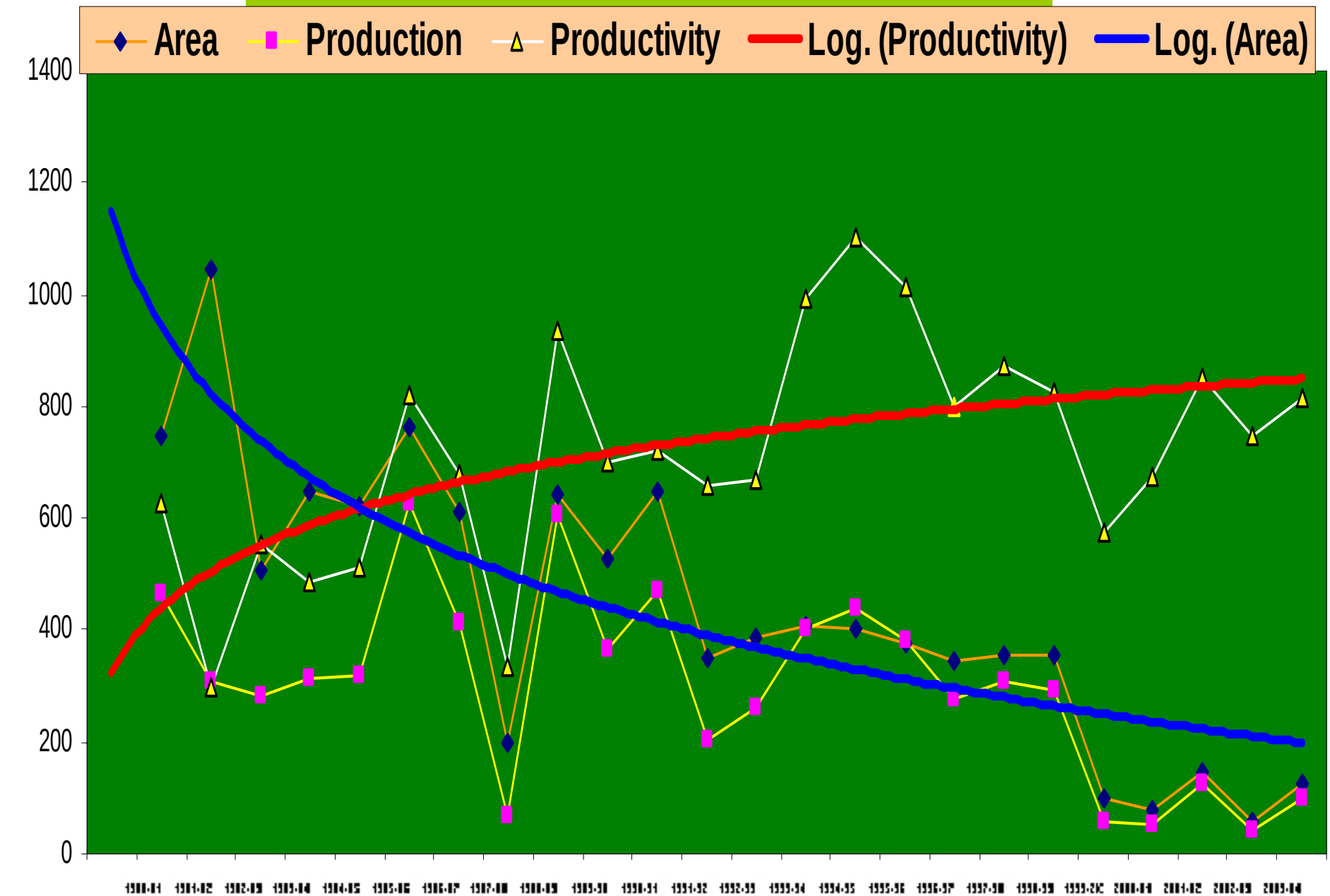
- **SRIVASTAVA et. al predicted :** A K SRIVASTAVA, B R D GUPTA* and B C PANDA(2009) IMPACT OF CLIMATE CHANGE ON CHICKPEA YIELD IN CENTRAL AND NORTHWEST INDIA. In : Challenges and Opportunities in Agrometeorology New Delhi 23-25 February, 2009

- **Yield increase under increased temp.**
- **45-47 % increase under double level of CO_2.**

Conclusions

- **Increase in Chickpea yield under projected climatic change scenarios by middle of this century in Central & North-west India.**

PRESENT TRENDS OF CHICKPEA in HARYANA



CHICKPEA SCENRIO IN HARYANA

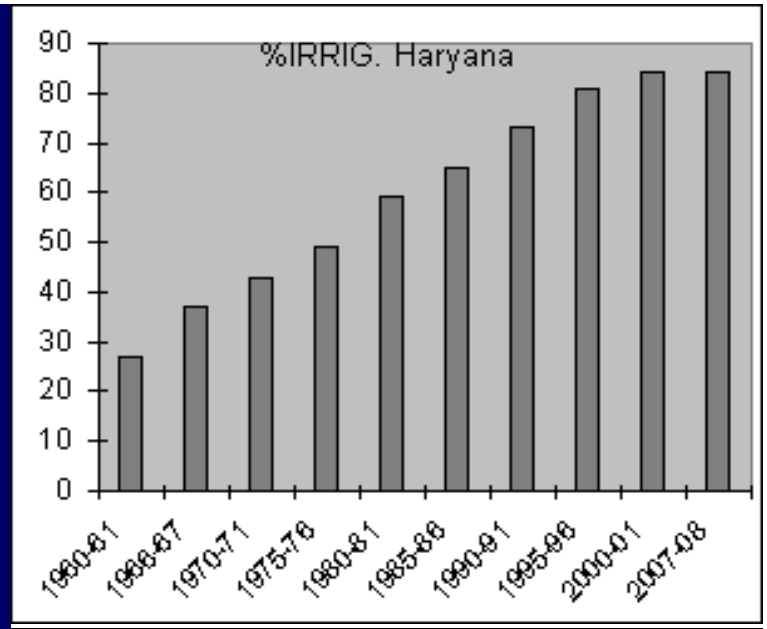
- 90 % REDUCTION IN AREAS

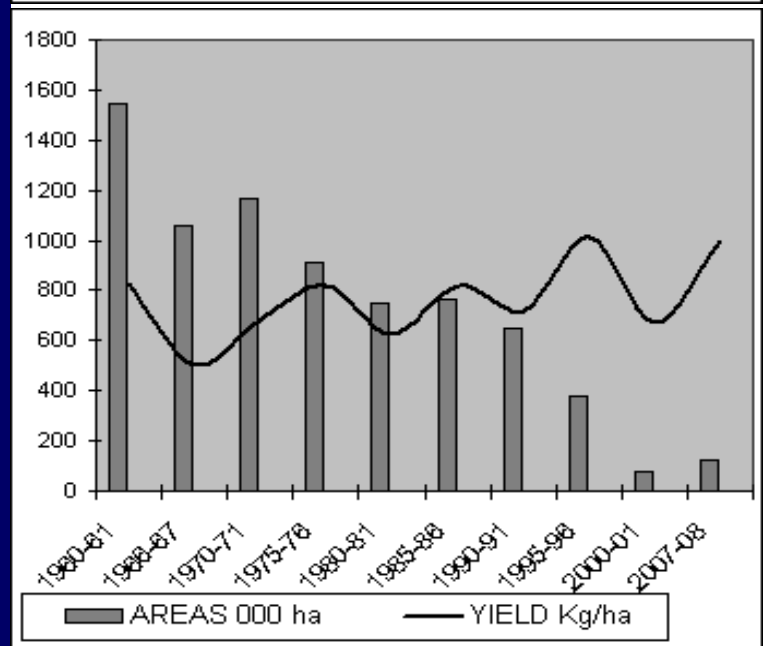
Induced Ecological Changes

- **Higher Moisture Ecology**
- Increased irrigation (23-87 %)
- **Increased Salinization**
- Introduction of Cereal HYV
- Govt. policy support (MSP etc)
- Poor response of traditional cultivars of chickpea to Changed Ecology

NEEDED ?

- **IMPROVED PLANT TYPE / IDEOTYPES FOR CHANGED ECOLOGICAL CONDITIONS**





CHICKPEA re-introduction in cropping system primarily depends upon

- Development of improved ideotypes for changed ecological condition of increase moisture and tolerance against abiotic stresses (salt, temp, moisture) & biotic stresses(pests & diseases)

- **The development of physiologically efficient chickpea ideotype HC-5 with erect and compact growth habit has shown positive response under changed ecological regimes of high moistures conditions and suitability for intercropping and mechanical harvesting**

HC-5

Improved Chickpea Ideotype
(Tall, Erect & Compact habit)

Performance of improved chickpea ideotype for yield traits

Sr. No	Characters	Traditional Ideotype (C 235)	Improved Ideotype (HC-5)
1.	Plant height (cm)	55.0±2.07	75.3±02
2.	No. of Primary Branches	4.07	8.76
3.	No. of Secondary Branches	14.86	9.98
4.	No. of tertiary / later order branches	18.2	1.80
5.	Canopy spread	29.89	17.67
6.	Fruiting zone (cm)	20.8	38.0
7.	No. of pods/plant	38.9	60.8
8.	No. of seeds/pod	1.80	1.22
9.	100 seed weight (g)	13.46	16.97
10.	Seed yield /plant (g) at 55 plants / sq.m)	3.73	6.60
11.	Biological yield / plant (g)	10.6	14.4
12.	Seed yield (kg/ha) at 33 plant / sq.m)	2659.00	2627.00
13.	Seed yield (kg/ha) at 55 plants / sq.m)	2803.00	3843.00

INTERCROPPING OF CHICKPEA IN SUGARCANE WITH BED-PLANTER

Conclusions

- **Climate changes a reality Now**
- **Indian agriculture likely to suffer losses in long run due to heat, erratic weather, decreased irrigation availability**
- **Adaptation strategies can help minimize negative impacts to great extent**
- **Need for research and policy support for Development of improved ideotypes / varieties & production technologies for changed climatic conditions.**