Agenda Item No. ii

- Detail briefing by Global Change Impact Studies Centre (GCISC) and dedicated Research Institute as well as Agriculture Universities (Punjab) to the Committee on Research for Wheat, Rice crops and what steps have been taken to share the research papers and coordination along with Federal as well as Provincial Government.

Climate Change & Agriculture: Research & Dissemination

Global Change Impact Studies Centre (GCISC)
Islamabad-Pakistan

Briefing to
National Assembly
Standing Committee on Climate Change
September 16, 2019

GCISC Status

- The Centre was established in 2002 as a PSDP Project and it remained attached with various organizations/ Ministries till 2013.
- The status of Body Corporate was granted under the GCISC Act notified through Gazette of Pakistan on March 26, 2013.

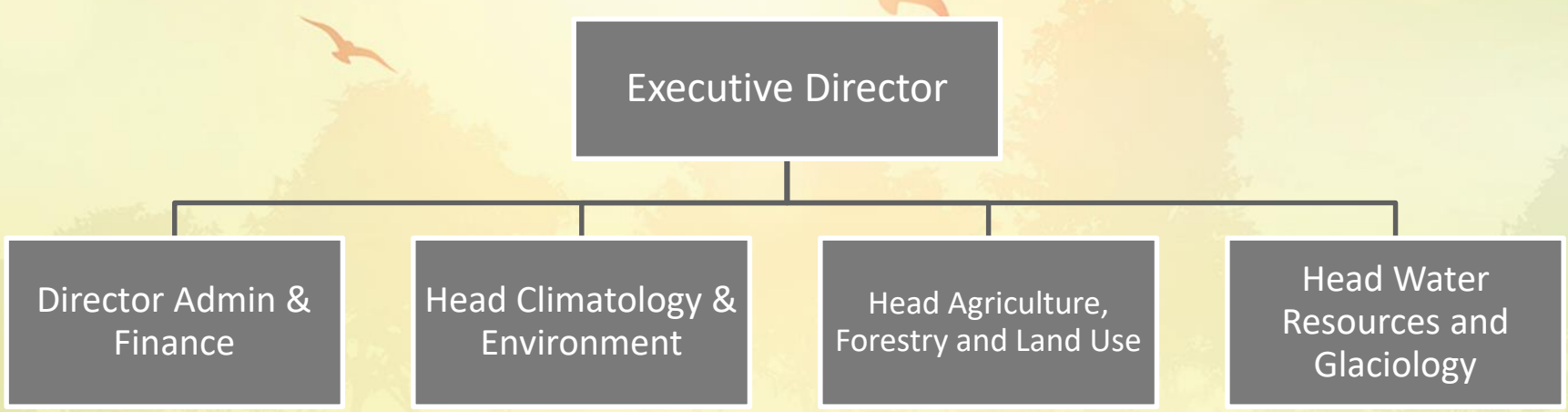
Mission Statement

To undertake scientific investigations of the phenomenon of climate change at regional and sub-regional levels and study its impact on various sectors of socio-economic development in order to prepare the country to meet threats to its water resources, agriculture, ecology, energy, health, bio-diversity etc.

Main Functions

- **Research**: on climate change profiles of Pakistan, climate change impact assessment in different socio-economic sectors and identification of appropriate adaptation/mitigation strategies;
- **Capacity building**: of young scientists of GCISC and the relevant national research organizations in climate change research;
- **Dissemination of research findings:** to scientific community, planners, policymakers and raising public awareness of climate change concerns.

Organogram


Executive Director
Director Admin & Finance
Head Climatology & Environment
Head Agriculture, Forestry and Land Use
Head Water Resources and Glaciology

Research

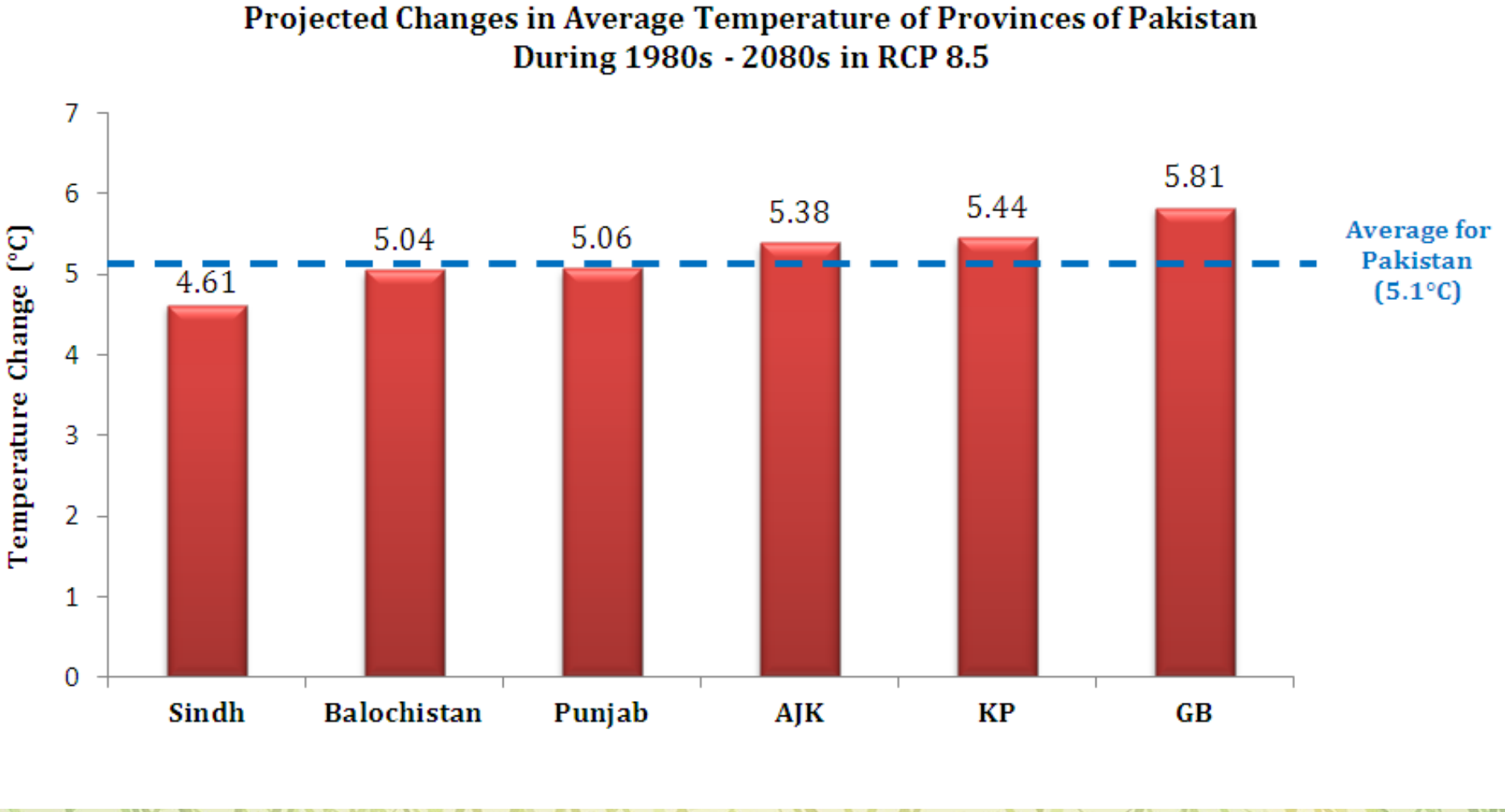
	Research Goals	Research Methods
Climate Science	Forecast changes in temperature, precipitation, glacier mass and melt, river flows, evaporation, pest and disease vectors, extreme events (floods, drought, cyclones)	**Models**: climate, glacier, heat island **Observations**: glacier mass, precipitation, temperature, crops, pests, disease, energy
Impacts	Assess impact on water, agriculture, health, ecosystems, energy	Water models, Crop models, Hydo-met extremes, water & energy demand and supply, disease vectors
Policy	Options to minimize/ avoid adverse impacts on life, health, livelihoods, development, and peace	Development policy, energy policy, agriculture policy, water policy, community building, capacity building, public health, conflict management

Agriculture & Climate Change

- Agriculture lies at the heart of many fundamental global challenges faced by humanity including;
  - Food security,
  - Economic development,
  - Environmental degradation, and
  - Climate change.

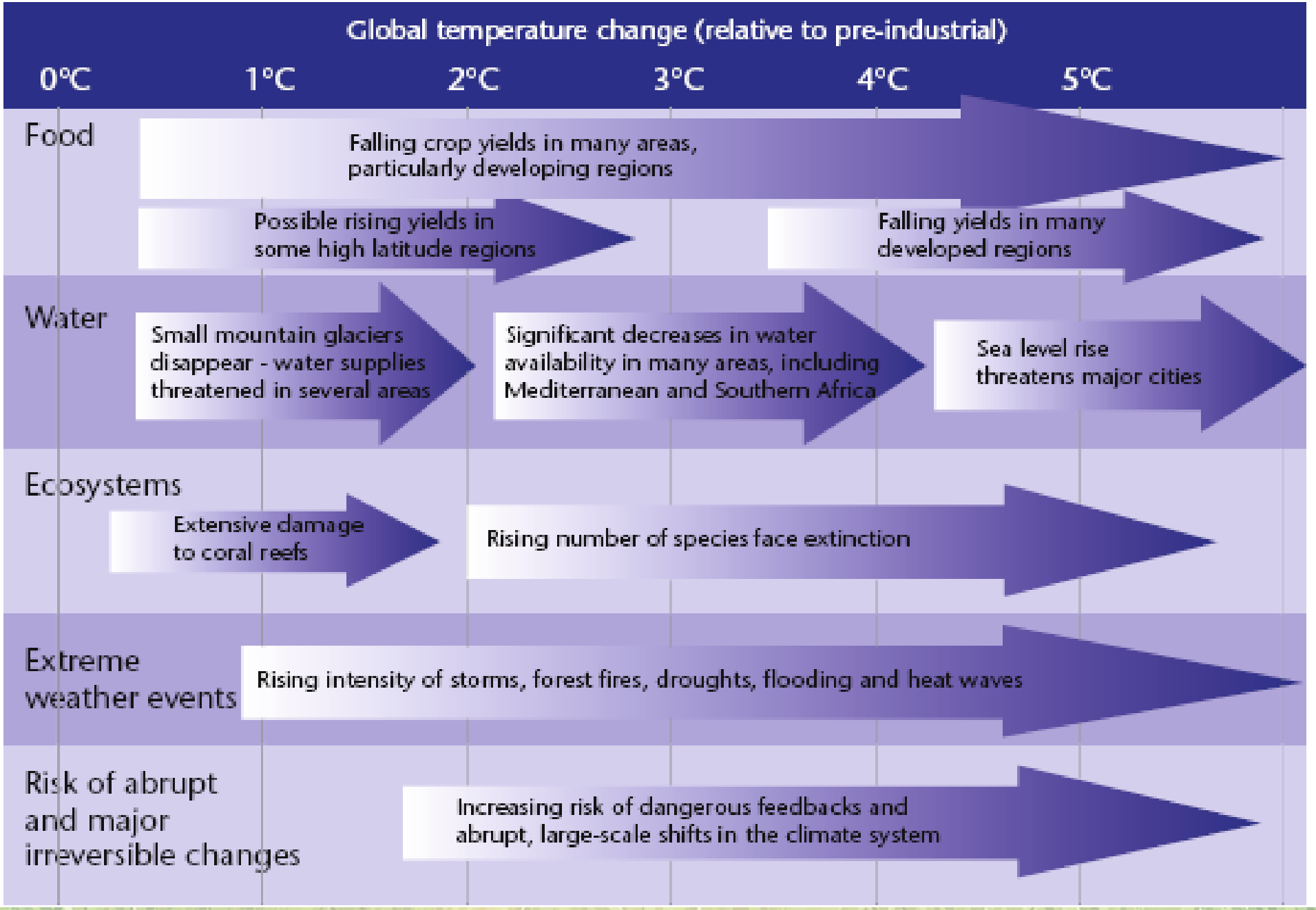
Agriculture – Pakistan's Perspective

Contribution to GDP	18.9%
Population	207 million
Workforce engaged	42.3%
Arable area	22 m ha
Agricultural Systems	Irrigated, Rainfed
Sub-Sectors	Crops, Livestock
Major Crops	Wheat, Rice, Maize, Cotton, Sugarcane
Cropping Seasons	Rabi (November – April) Kharif (May – October)
Major Livestock Species	Buffalo, Cow, Goat and Sheep


Projected Changes in Average Temperature of Provinces of Pakistan
During 1980s - 2080s in RCP 8.5
Temperature Change (°C)
0
1
2
3
4
5
6
7
4.61
5.04
5.06
5.38
5.44
5.81
Average for Pakistan (5.1°C)
Sindh
Balochistan
Punjab
AJK
KP
GB

Impacts


WHAT HAPPENS TO AGRICULTURE WHEN THE CLIMATE CHANGES?
FARMERS



IPCC 4AR, 2007

Agriculture & IPCC 1.5°C Report

- Climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5°C and increase further with 2°C;
- These risks could overlap spatially and temporally, creating new and exacerbating current hazards, exposures, and vulnerabilities that could affect increasing numbers of people and regions;
- Limiting warming to 1.5°C compared with 2ºC is projected to result in smaller net reductions in yields of maize, rice, wheat, and potentially other cereal crops;
- Livestock are projected to be adversely affected with rising temperatures, depending on the extent of changes in feed quality, spread of diseases, and water resource availability;
- Adaptation is expected to be more challenging for ecosystems, food and health systems at 2°C of global warming than for 1.5°C

Impacts of Climate Change on Agriculture

Single factor that is likely to exert adverse impacts on productive resources and ultimately on agricultural productivity

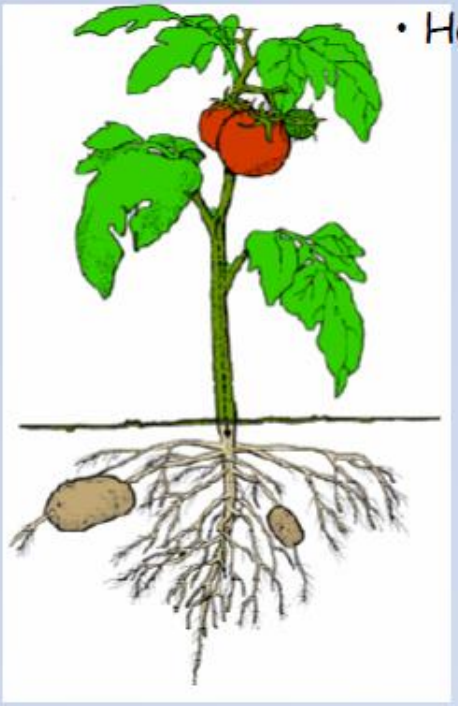
- **Loss in crop yields**
- **Shortening of Growing Season Length**
- **Increased evapotranspiration**
- **Increased land degradation**
- **Decreased livestock productivity**

TEMPERATURE

- Vegetative and reproductive development
- Evapotraspiration
- Soil organic matter transformations, nutrient availability
- Frost
- Diseases and weeds development
- Heat wave

PRECIPITATION

- Water stress and drought
- Plant growth
- Disease outbreak
- Flood and soil erosion
- Hail and snow



SOLAR RADIATION

- Photosynthesis
- Evapotraspiration
- Temperature in soil and canopy
- Crop growth and final yield
- Tissues burning

WIND

- Evapotraspiration
- Gas exchanges
- Breaking off and crop setting

Ongoing Research Programme (GCISC)

- Assess impacts of projected climate changes on productivity of key agricultural crops in different climatic zones using crop models;
- Food security in the face of future climate change and especially reduced availability of irrigation water;
- Adaptation measures, including smart agriculture;
- Studies on water, food, energy nexus;
- Updating GHG emissions from agriculture and related sectors.

Tools for Climate Impact Assessment: Simulation Models

Crop Simulation Models :

DSSAT: Decision Support System for Agro-technolog Transfer (Univ. of Georgia, Griffin, USA) comprising several families of models:

* CERES (for cereals)
* CROPGRO (for grain legumes)
* CROPSIM (for root crops)
* Other Crops (for Tomato, Sunflower, Sugarcane, Pasture)

InfoCrop: Indian Council for Agriculture Research

AquaCrop: Food & Agriculture Organization, Italy

APSIM: Agricultural Productivity Simulator, Australia

Water Management Models:

* **PODIUM:** Policy Dialogue Model, International Water Management Institute, Sri Lanka
* **CROPWAT:** FAO, Italy

Simulation Process In a Crop Model

Growth and Development Data

Irrigation Data

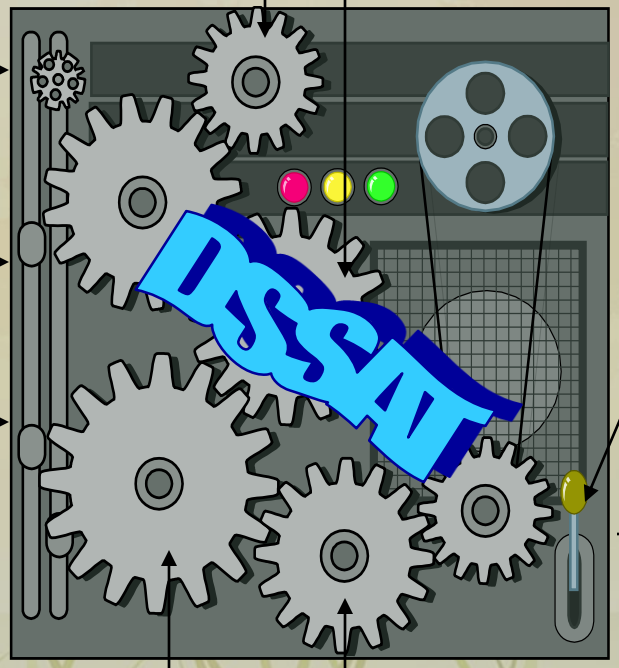
Soil Data

Weather Data

Cultivar File

Species File

Model.exe



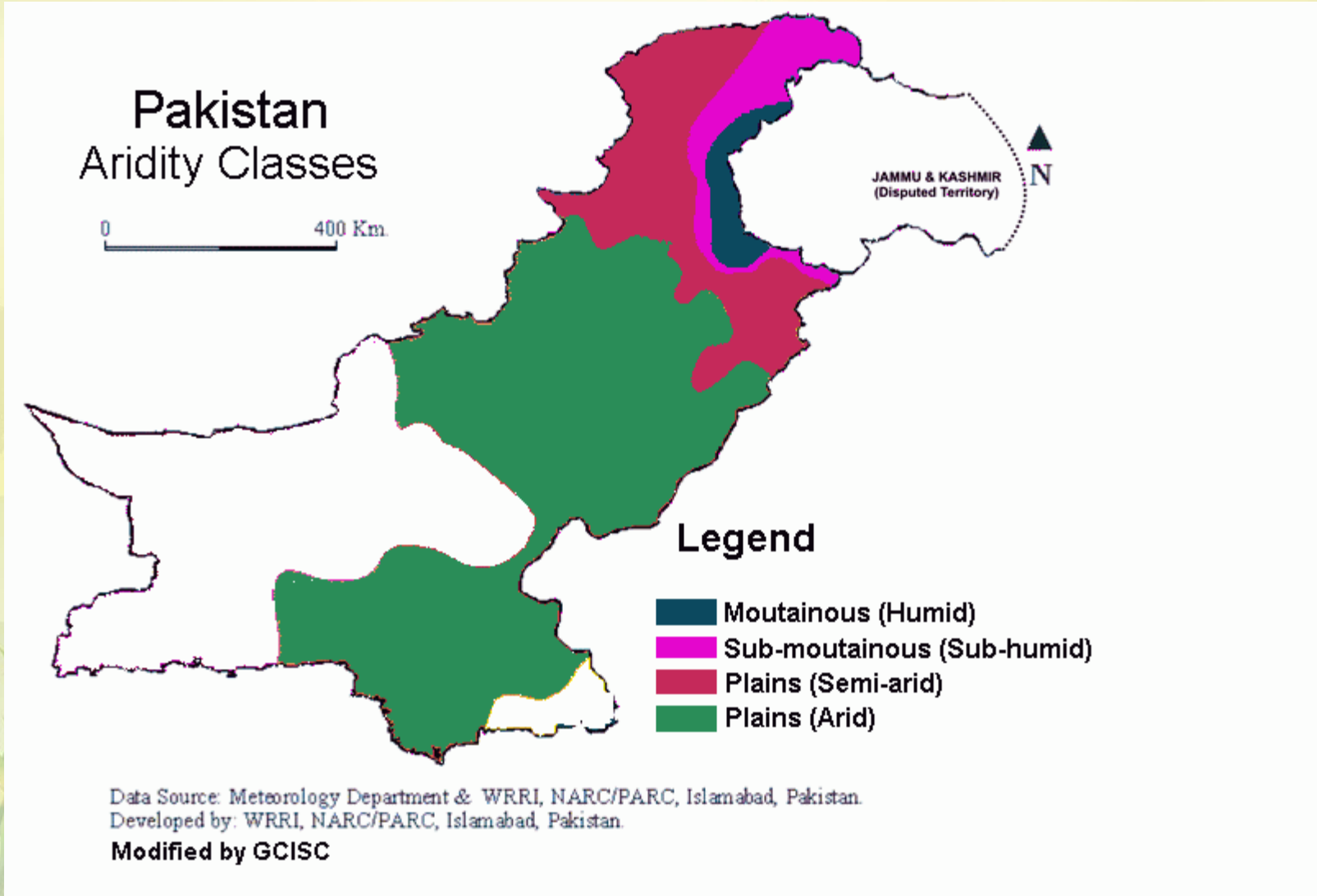
X-File

Ecotype File

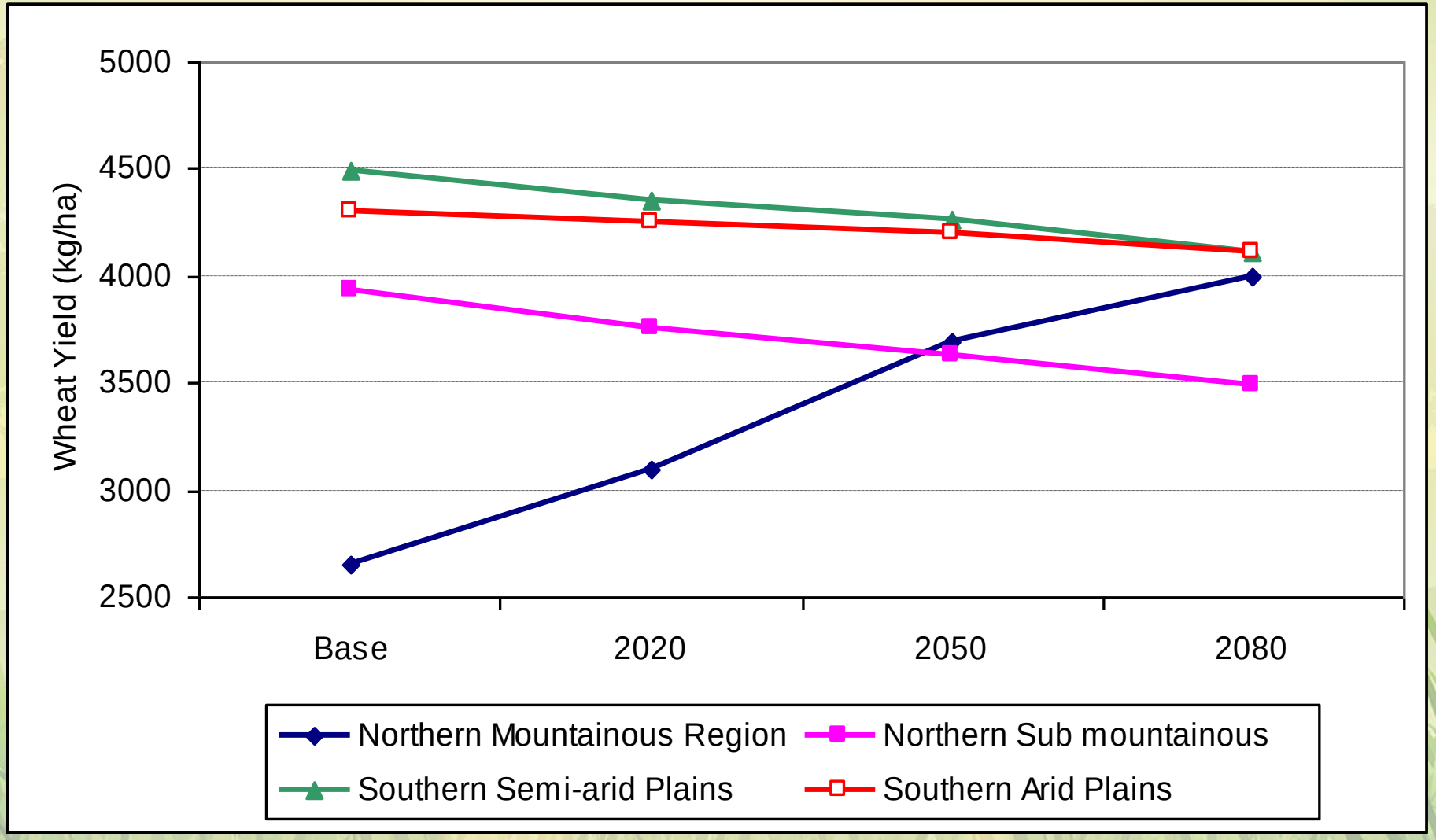
Simulation Output

Findings of
APN-CAPaBLE Project
(2005-CRP1CMY-Khan) On Food Security
(conducted at GCISC)

Agro-climatic zones used by GCISC for Climate Change Impact Studies on Agriculture



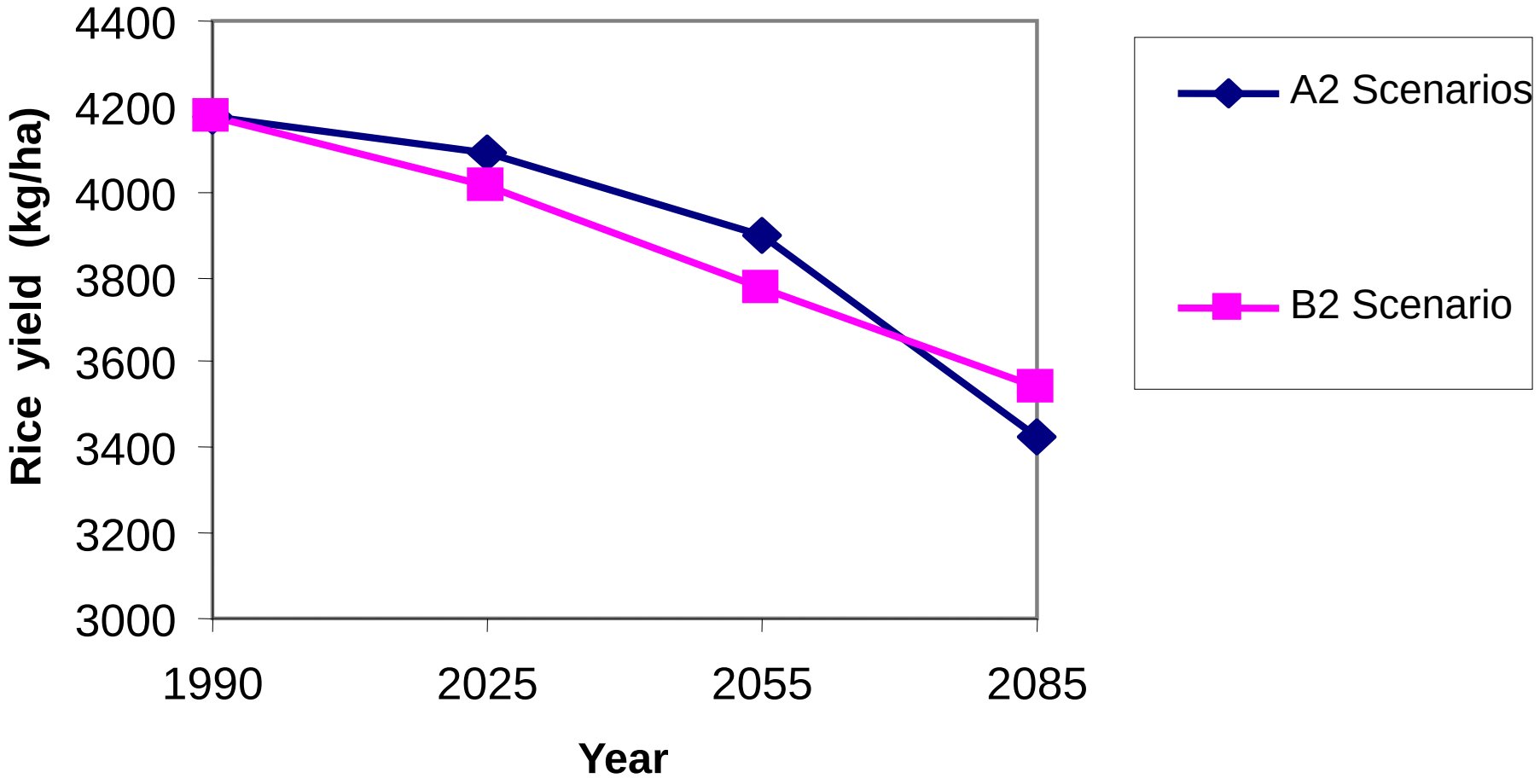
Wheat Yield in different agro-climatic zones of Pakistan under A2 Scenarios



Climate Change Impact on Wheat Production in Pakistan by 2085 under A2 and B2 Scenarios

Region	% Share in National Production	Baseline Yield (kg ha^{-1})	% Change in yield in 2085	
			A2 Scenario	B2 Scenario
Northern Mountainous	2	2658	+50	+40
Northern Sub-mountainous	9	3933	-11	-11
Southern Semi arid Plains	42	4306	-8	-8
Southern Arid Plains	47	4490	-5	-6
Pakistan	100	4326	-5.7	-6.4

Basmati Rice Yield in Southern Semi-arid Plains of Pakistan under A2 and B2 Scenarios



Yield decrease by 2085:18% in A2 and 15% in B2 Scenarios

Findings of APN-Iqbal Project
On Food Security
(conducted at GCISC)

Yield Projections – Wheat

- **Semi-arid Areas**

  Faisalabad & Sheikhupura 3.4-12.5% Reduction

- **Arid Areas**

  Badin & Hyderabad 3.9-13.4% Reduction

  Multan & Bahawalpur 4.0-10.05 Reduction

- **Rainfed Areas**

  Chakwal District upto 16% Reduction

Yield Projections

- **Rice**
  - Rice tract of central Punjab: 10.4-21.5% Reduction
- **Cotton**
  - Southern Punjab: 32-44% Reduction
  - Cotton zone of Sindh: 38-47% Reduction

Growing Season Length (GSL) Projections for Wheat and Rice

❑ Wheat

Semi-arid Areas

Fsd & Shk'pura	Reduced from 148 to 120 days

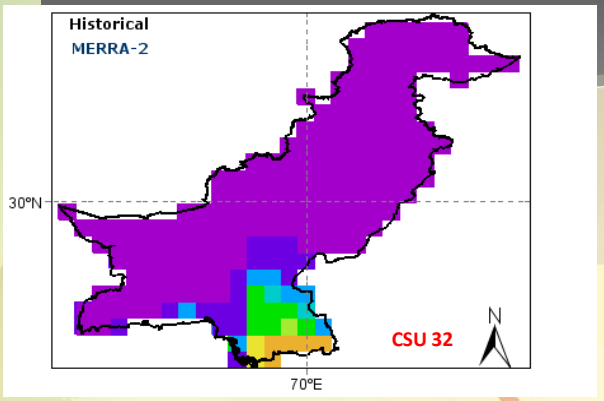
Arid Areas

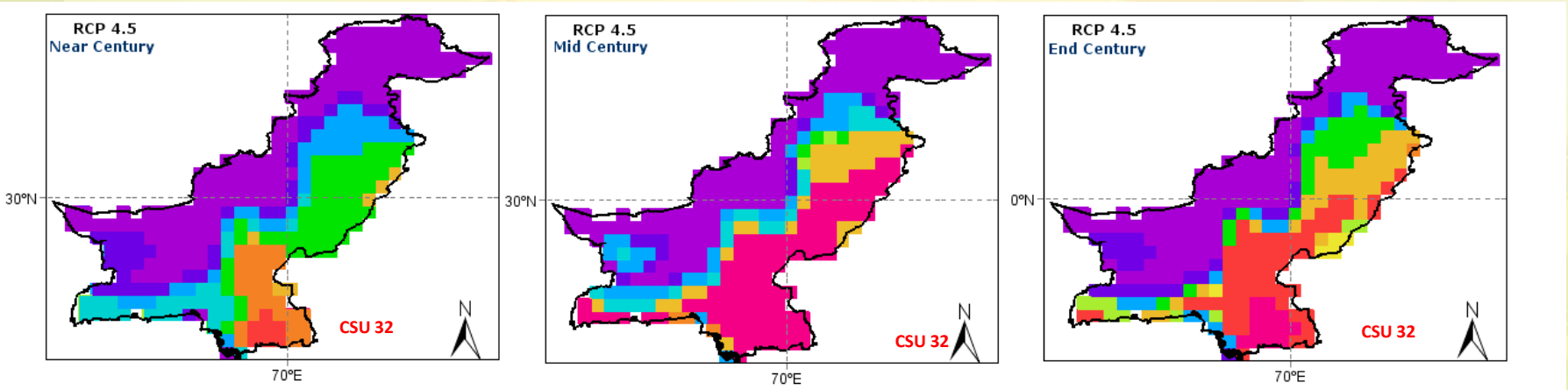
Badin & Hydrabd	Reduced from 134 to 113 days
Mltan & Bhwl'pur	Reduced from 138 to 117 days

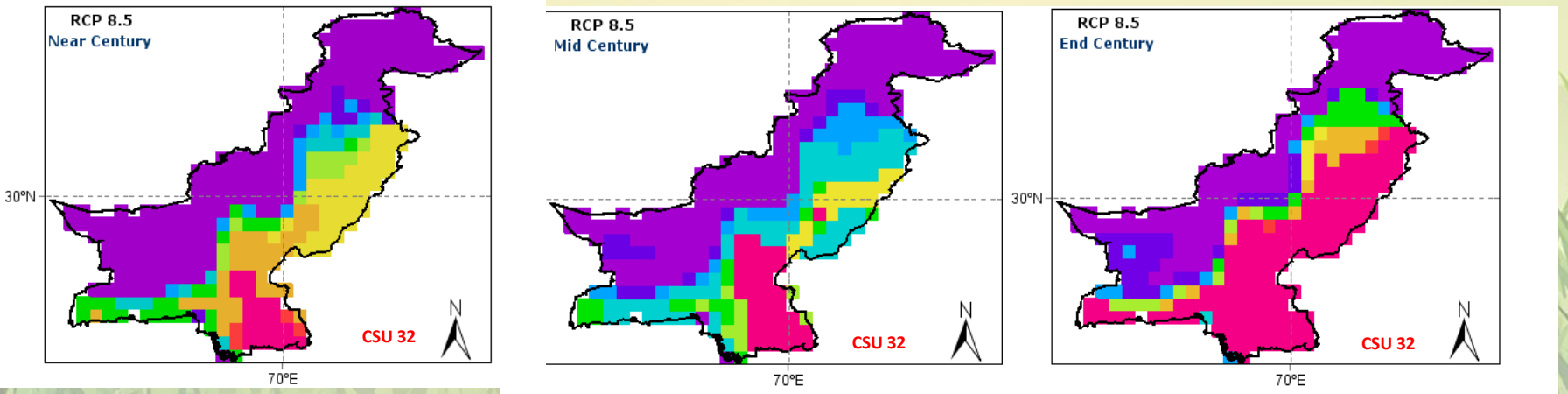
❑ Rice

Basmati rice tract	Reduced from 110 to 98 days

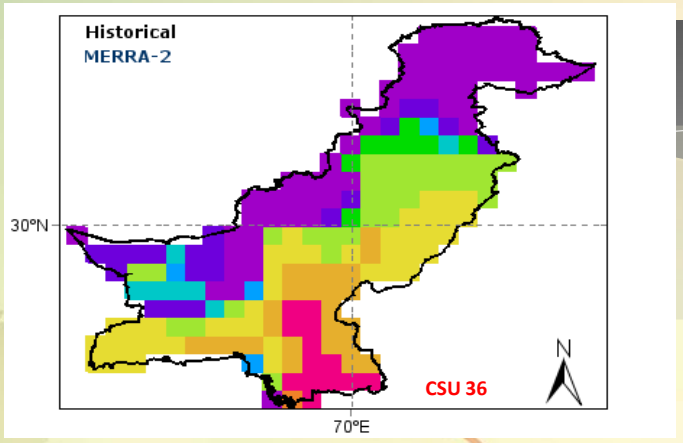
Consecutive Summer Day Index (32 ^{0}C) during Flowering in Wheat

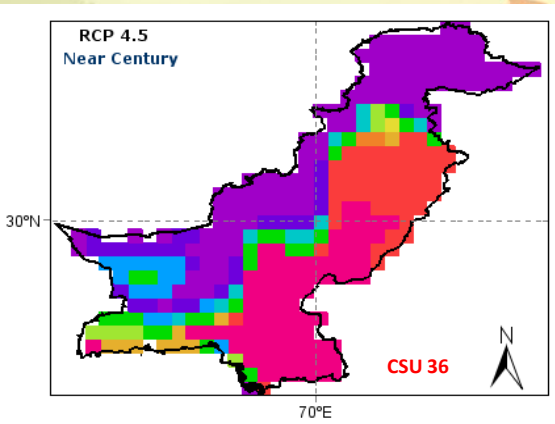


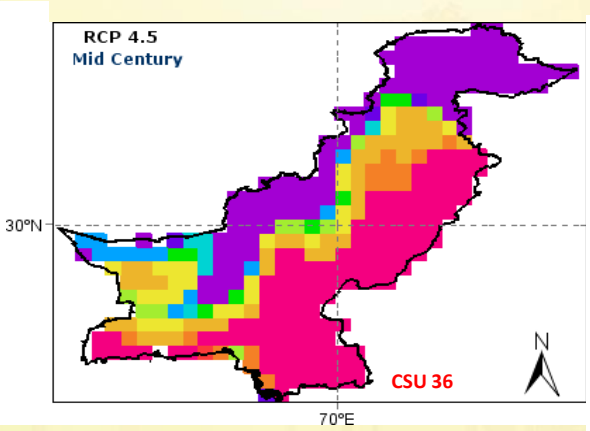


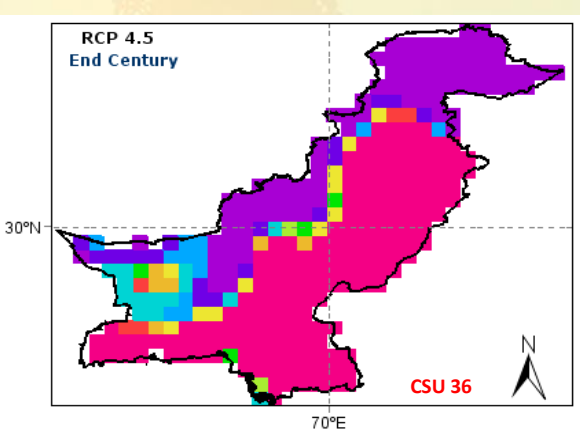


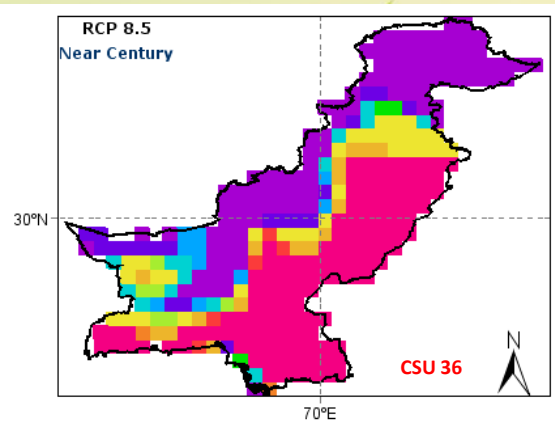
Consecutive Summer Day Index (36 ^{0}C) during Ripening in Wheat

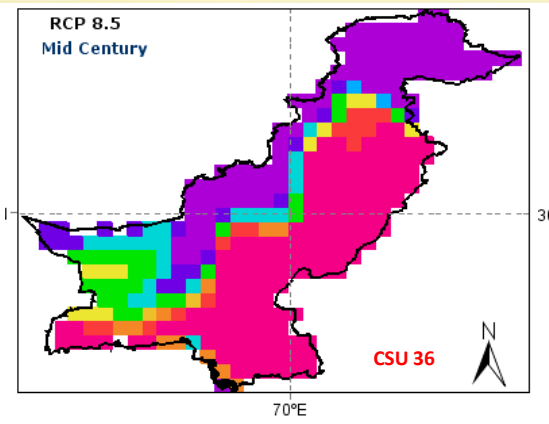


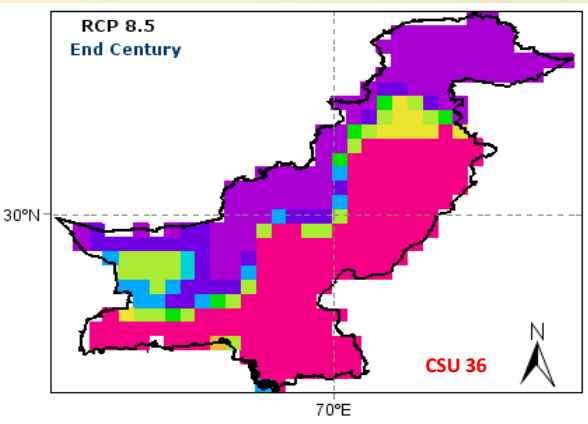


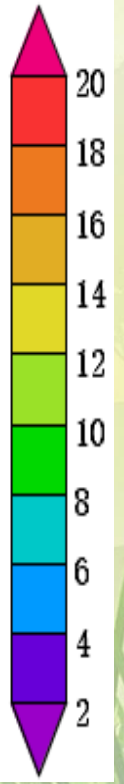












Adaptation

Adaptation Options in Agriculture

1. Agronomic management
2. Water harvesting and exploitation
3. Water Use efficiency
4. Crop intensification
5. Alternative crop enterprises
6. Post harvest practices

Adaptation Approaches in Crop Sector

- **Crop Management** (studies carried out at GCISC)
  - *Changing the Crop Sowing window,*
  - *Irrigation scheduling,*
  - *Split vs Full Application of Fertilizer,*
  - *Changing the Planting Techniques,*
  - *crop rotation*

- **Genetic Improvement:**

  Increased tolerance to high temperature, drought and heat stress
- **Improving water use efficiency**:

  By high performance irrigation techniques
- **Crop Diversification**
- **Mixed Crop-Livestock farming systems**

Adaptation Strategies under the Project: Fertilization Management

- **Effect of improved fertilization**

  The rate of 175 kg N/ha (in place of 125 and 150 kg N/ha) sustained baseline wheat yield upto 2020s and 2050s under A2 and B2 scenario.

- **Effect of split application of fertilizer**

  Fertilizer application in 3 splits (at sowing, 1st irrigation and tillering) compared to commonly practiced 2 splits (at sowing and tillering) or whole fertilizer application at sowing improved wheat yield.

Adaptation –Efficient Water Management

- **Improved irrigation scheduling**

  Applying the same amount of water (225 mm) in 5 irrigations to wheat (at crown root initiation, tillering, late jointing, flowering and dough stages) instead of conventional 3 irrigations improved yield upto 38% by 2020s.

- **Direct seeding of rice**

  Direct seeding of rice led to increased water use efficiency without adverse effect on yield.

Adaptation –Management of Cultural Practices

- **Effect of change in sowing window**

  Early sowing out of 3 sowing dates tried (2nd week of October, 2nd week of November and 2nd week of December) showed some promise but it had problems of interfering with sowing of preceding or next crop.

- **Effect of increase in seed rate**

  Higher seed rate for wheat (150 kg/ha instead of 125 kg/ha) maintained the baseline yield upto 2020s.

Steps Taken to Coordinate and Share Research

1. Joint studies

- **Pakistan Agricultural Research Council -** Assessment of Climate Change Impacts on Rainfed Cropping Systems under 2°C Scenario
- Assessment of Climate Change Impacts on livestock production, adaptation and mitigation strategies
- **University of Agriculture, Faisalabad** - Assessment of Climate Change Impacts on wheat-rice and wheat-Miscellaneous cropping systems under 2 °C scenario.
- Assessment of Climate Change Impacts on high value crops under 2 °C scenario.
- **US Pakistan Centre for Advanced Studies in Agriculture and Food Security, UAF** - Identification of shifts in cropping patterns under 2 °C scenario
- Obstacles to the adoption of climate friendly technologies in the farmer fields and possible solutions

- **Pir Mehar Ali Shah Arid Agricultural University** -Spatiao-temporal dynamics of greenhouse gas emissions from soils under various forest types of Pakistan
- **Karakoram International University -Prospects of crop production in the mountainous ecosystems under changing climate**
- This study analyzed the effect of yearly changing climate at different sites and production of potato, maize and wheat in Gilgit-Baltistan. The results showed that production rates in some regions of GB like Shigar and Passu are increasing with increase in temperature whereas other regions like Bagrut are deceasing.

2. International Projects

- Climate smart agriculture through sustainable water use management: Exploring new approaches and devising strategies for climate change adaptation in South Asia;
- Climate-smart agriculture implementation through community-focused pursuit of land and water productivity in South Asia ;
- Study on Preparation of project on Food Nutrition Monitoring System;
- Transformation to Climate Smart Agriculture: Increasing farmer resilience to drought and reducing carbon emissions in climate-vulnerable areas of Pakistan;

❑ **Proposals Submitted to GCF in Collaboration with FAO and WWF**

- Integrated Flood Risk Management: Building Pakistan's Resilience to Climate Change through Ecosystem-Based Adaptation.

3. Provincial Government Representation in BoG-GCISC

- Secretary, Environment or of the relevant Department and one Technical Expert nominated by respective Provincial Governments, Azad Governments of Jammu and Kashmir and Gilgit Baltistan are Ex-officio members of the Board as given in GCISC-Act 2013.
- On going and planned GCISC research is shared during each meeting of the BoG.
- Comments and concerns of the provincial representatives are recorded and incorporated in GCISC research.

4. Policy Input to Federal Government

- Contribution in formulation of National Policy related to Agriculture, Forestry and Food Security
- Submission of policy briefs to MoCC
- Submission of responses to questions received from National Assembly and Senate of Pakistan.

5. Research Seminars/Workshops/Conferences

- Weekly research seminar on every Friday is organized at GCISC inviting speakers from academia, research institutes, NGOs, community projects' representatives from international, national, provincial and local levels.
- Annual policy seminars for policy makers from national and provincial level (subject to availability of funds).
- Annual Science Policy Conference on Climate Change (SP3C) involving international, national, sub-national and local level researchers, academicians, students, journalists, parliamentarians and community representatives (subject to availability of funds.

6. Capacity Building Workshops/Trainings

- Time to time capacity building workshops and trainings are organized at GCISC for imparting training on the new research techniques, models to the students, researcher and academicians from national and subnational level.
- GCISC also provides resource persons to different research and development organisations, universities and community organisations in order to impart knowledge and trainings on climate change related issues.
- Capacity building of provincial agricultural research departments is done by engaging/involving as collaborators in international projects.

7. Surveys/ Field Visits

- GCISC conducts surveys/field visits in collaboration of international, national and subnational partners for the preparation of need assessment reports in the context of climate change.
- GCISC with its partners from agricultural extension departments, NRSP and PPAF, also contributes in disseminating first hand information/knowledge to the farmers to cope with short term climate challenges.

8. Awareness Activities

- Participation in roundtable discussions, panel discussions and consultation meetings organized by various organizations;
- Participation in TV programs on PTV, GEO, SAMAA, CNBC and Value TV and other channels;
- Participation in radio programs at Radio Pakistan and BBC;
- Participation in national and international conferences, workshops or seminars;
- Organization of a weekly lecture on climate related subject;
- Organization of national workshops.
- Organization of dedicated series of workshops on Food Security and Impacts & Adaptation as part of Pakistan's largest international climate conference *Science Policy Conference on Climate Change (SP3C-2017)*.

Key Contributions in fulfilling Pakistan's international commitments

- Served as the Secretariat to Prime Minister's Committee on Climate Change (PMCCC) from 2003-08
- Planning Commission's taskforce Report on Climate change
- National Climate Change Policy & other Sectoral Policies
- Framework for the Implementation of Climate Change Policy
- Pakistan-Nationally Determined Contributions Study
- Pakistan's Second National Communication (SNC)

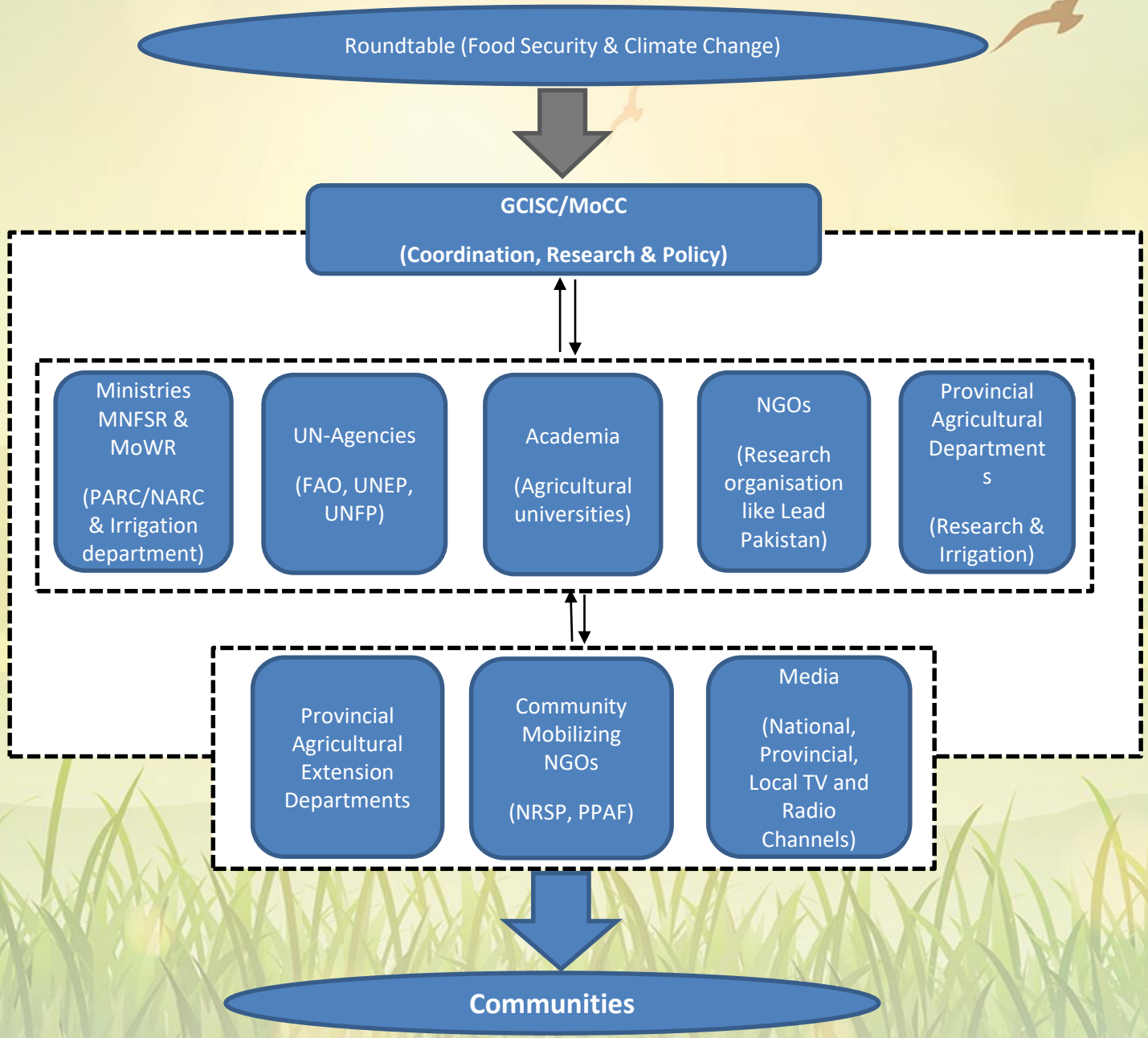
Future Plans and Initiatives for Research Sharing, Capacity Building and Climate Services

- GCISC (as per GCSIC Act) intends to starts its sub-centres at all four provinces including GB and AJK so that a more coordinated research with the federating units can be conducted and more accurate and targeted climate services can be delivered.
- GCISC intends to start Climate Summer Schools on annual basis, where international climate experts will be engaged to teach and train national and provincial researchers across the country.
- GCISC also plans to continue annual Science Policy Conference on Climate Change (SP3C) at Islamabad for sharing research papers and findings with national and international science community.

Cont…..

- GCISC is at kick-off stage to establish a permanent roundtable of climate change, agriculture and food security by involving representatives from national and provincial agricultural research, irrigation and extension departments, agricultural universities, food and agriculture related UN organisations, NGOs and media (Concept note attached).
- GCISC has almost started working on the plan for establishment of Food, Energy, Water Security Early Warning System (FEW-EWS) in the Indus Basin comprising institutions; GCISC, PMD, Federal and Provincial Agricultural departments and other related organisations (Concept note attached)

Framework of Roundtable on Climate Change, Agriculture and Food Security




Thank you!