1. Agricultural situation
2. Climate change scenario
3. Agricultural options
4. CSISA role & partnership
   - Knowledge banks, -CKB -HCP

Climate change changing world contours
- Population (9b in 2050)
- Industrialization
- Agriculture and its input use
- Globalization and market integration
- Consumerism
  - Resource base exploitation/deterioration

Development cycle
- Emission up 31%, projection ≈ 2ppm Year⁻¹
- Earth temperature up 0.74 °C
- Poised to increase 2.4 °C
- Decreasing water availability
- Receding Himalayan glaciers (20%)¹
- Vanishing poles (100 km³/year)

Anthropogenic effects more pronounced today
- CO₂ values up from 280 to 390 ppm
- Emission up 31%, projection ≈ 2ppm Year⁻¹
- Earth temperature up 0.74 °C
- Poised to increase 2.4 °C
- Decreasing water availability
- Receding Himalayan glaciers (20%)¹
- Vanishing poles (100 km³/year)

Climate change causes GHGs
1. Water vapors (33-66%GHGs)
2. CO₂ (9-26%)
3. Methane x20(4-9%)
4. N₂O x298
5. O₃ x25
6. CFCs
Carbon footprint of wheat crop in Pakistan

<table>
<thead>
<tr>
<th>Operation</th>
<th>Fuel used (m.lit.)</th>
<th>CO₂ prod. (m.tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>2020</td>
<td>2010</td>
</tr>
<tr>
<td>Cultivation</td>
<td>484.64</td>
<td>530.4</td>
</tr>
<tr>
<td>Sowing</td>
<td>78.17</td>
<td>85.5</td>
</tr>
<tr>
<td>Herb. App.</td>
<td>27.45</td>
<td>30.0</td>
</tr>
<tr>
<td>Threshing</td>
<td>134</td>
<td>146.6</td>
</tr>
<tr>
<td>Total</td>
<td>724.3</td>
<td>792.6</td>
</tr>
</tbody>
</table>
Global temperature changes. Left: 1880-89. Right: 2000-09. NASA conducted the analysis using ship-based and satellite observations of sea-surface temperature, and data from Antarctic research stations and 6,300 meteorological stations around the world. Earth’s average surface temperature has increased by about 0.7 °C (1.3 °F) since 1880. Two-thirds of the warming has occurred since 1975, at a rate of roughly 0.15 to 0.20 °C per decade. Credit: NASA GISS. Courtesy of the NASA Earth Observatory and Mike Carlowicz.

“The frequency, and intensity of extreme events are expected to change as Earth’s climate changes.” (IPCC, 2007)

How can crops adapt to:
- Heat waves?
- Delayed rains?
- Temporary flooding?
- Combinations of stresses?

Challenge
- At our current rate of consumption, human require equivalent of 1.4 planet to provide the resources we use and absorb our waste. As greenhouse gas emissions increase along with our rate of consumption, the situation will worsen.
  Reduce consumption we have one planet.
Rising world population

<table>
<thead>
<tr>
<th>Year</th>
<th>Population (billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>5.3</td>
</tr>
<tr>
<td>2000</td>
<td>6.1</td>
</tr>
<tr>
<td>2020</td>
<td>7.7</td>
</tr>
<tr>
<td>2050</td>
<td>9.1</td>
</tr>
</tbody>
</table>

Population trends in Pakistan

<table>
<thead>
<tr>
<th>Year</th>
<th>Population (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>108</td>
</tr>
<tr>
<td>2000</td>
<td>137.5</td>
</tr>
<tr>
<td>2020</td>
<td>211.4</td>
</tr>
<tr>
<td>2050</td>
<td>267.8</td>
</tr>
</tbody>
</table>

Dwindling land for agriculture

<table>
<thead>
<tr>
<th>Year</th>
<th>Per Capita Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>0.44</td>
</tr>
<tr>
<td>1971</td>
<td>0.32</td>
</tr>
<tr>
<td>1981</td>
<td>0.24</td>
</tr>
<tr>
<td>1991</td>
<td>0.16</td>
</tr>
<tr>
<td>2001</td>
<td>0.13</td>
</tr>
<tr>
<td>2010</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Demand for cereals will double by 2050

Area sown to staples in developing countries

Projected population and wheat requirement

<table>
<thead>
<tr>
<th>Year</th>
<th>Population (million)</th>
<th>Wheat Required (m. ton)</th>
<th>Yield (t/ha)</th>
<th>Area Need (000 ha)</th>
<th>Area released (000 ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>173.5</td>
<td>22.90</td>
<td>2.6</td>
<td>9042</td>
<td>-</td>
</tr>
<tr>
<td>2015</td>
<td>205.5</td>
<td>27.13</td>
<td>3.5</td>
<td>7750</td>
<td>1292</td>
</tr>
<tr>
<td>2020</td>
<td>226.2</td>
<td>29.86</td>
<td>4.0</td>
<td>7464</td>
<td>1578</td>
</tr>
<tr>
<td>2025</td>
<td>246.3</td>
<td>32.51</td>
<td>4.3</td>
<td>7560</td>
<td>1482</td>
</tr>
<tr>
<td>2030</td>
<td>265.6</td>
<td>35.07</td>
<td>4.6</td>
<td>7624</td>
<td>1418</td>
</tr>
</tbody>
</table>

Challenge to Food Security

Production vs. Consumption

- Total Production
- Total Consumption
- Human
- Animal
- Surplus
- Others

Note: *Human needs = 10% seed and feed requirements
Rising temperatures and crop production

- Land reclassification by 2050
- 1 °C rise would mean ≈ 7% wheat yield loss
- 1 °C rise would mean ≈ 10% yield loss in rice
- 44% yield loss in rainfed wheat yield
- Significant pests, pathogen and weeds changes
- Deleterious effects on grain quality and nutrients
A disappearing Arctic ice cap

Time, December 6, 2010

Future scenario
- Challenges
- Compulsions
- Approaches

Present day agriculture would not be the answer to emerging situation

New guiding philosophy
- More with less
- Save as we grow prosperity for all
  - more production
  - more income
  - better health

Translated into actionable propositions it means:
- Increased food availability
- Reduce cost of crop production
- Maintain momentum of growth
- Promote biodiversity
- Eliminate poverty
- Conserve environment
  - Soil, water and air
  - Reduce energy use
Achievable by:
Deployment of innovative combination of factors of production using CA platform

Solutions
- Simple
- Cheap
- Effective

Conservation Agriculture
Resource saving crop production practices which aim at:
- Sustainable high production
- Crop/system profitability
- Natural forces enhancement
- Input optimization
- Resource conservation

CA (climate smart agriculture) -
- Integrates agri. technology with environment management by promoting:
  - Crop rotation
  - Maintaining soil cover
  - Minimum soil disturbance
- improves rain infiltration, reduces erosion and water requirement upto 30%, improves drought tolerance

Integrated Crop and Resource Management
“Ecological crop Intensification”

RC technologies
- Laser leveling
- Zero till
- Bed planting
- DSR
- Controlled irrigation management in rice
- SSNM
- Balanced /efficient fertilizer use
- Residue management
- Increased cropping intensity/diversity
- New seed/cultivars
RC technologies
• Laser land leveling
• Direct seeded rice
• Unpuddled transplanted rice
• Reduced tillage (i.e. strip tillage or fewer tillage passes)
• Zero tillage
• Raised bed planting
• Increased application rates of fertilizer
• Decreased application rates of fertilizer
• Application of micro-nutrients
• Liming
• Improved weed management
• Increased irrigation frequency
• Decreased irrigation frequency
• Change in irrigation timing
• AWD - alternating wetting and drying

RC technologies/cont.
• Increased cropping intensity (i.e. more crops per year)
• More cropping diversity (i.e. replacing existing crops with different crop types)
• New varieties of rice
• New varieties of wheat
• Improved post-harvest storage
• Seed priming or treatment (fungicide, insecticide)
• Split applications of nitrogen
• Banded fertilizer application
• Deep placement of urea supergranules (USG)
• Leaf color chart
• Nutrient Manager software
• GreeSeeker sensor
• Brown manuring
• Stale seedbed

Laser leveling – tabletop fields
• Eliminates high/low points
• Reduces irrigation times
• Saves water (= 20 %)
• Saves labor

Water use (m3/ha) in wheat under precision and traditional land leveling

Effect of laser land leveling on water use (m3/ha) in raised bed planted wheat

0-til planting
• No land preparation
• Cost saving
• Timely crop planting
• Builds soil organic matter
• Reduces compaction
• Promotes biodiversity
• Improves yield
• Environment friendly
Effect of Residues on Crop Production

Data of K. Sayre from central Mexico

Bed planting

- Water saving
- Improves crop establishment
- Reduces crop lodging
- Reduces disease incidence
- Improves yield
- Crop establishment in saline/sodic soils

World-wide adoption of Zero-tillage 2008

Millions of hectares

Total = 105.9 million ha.

Based on Derpsch and Friedrich, 2009

Haryana, India

Indian Punjab

Figure 9: Tillage and residue management effects on wheat productivity, winter 2006–07, Haryana, India (148)

Figure 10: Comparative wheat grain yield under conventional till broadcast (incorncob) and zero till with surface residues (Turbo seeder), Punjab India (Hrs 152)

World-wide adoption of Zero-tillage 2008

Millions of hectares

Total = 105.9 million ha.

Based on Derpsch and Friedrich, 2009
**Wheat in gypsum amended sodic soils**

**DSR and AWD in rice**
- DSR
  - Saves 75% of planting cost
  - 30% water
  - Reduce labor needs
  - Reduce energy needs
  - Optimal population
- AWD
  - Saves 30% water

**ZTBP in operation**

**Bed planted wheat**

**ZT wheat**

**ZT vs CP**

Weed management a challenge
Residue Management

- Moderates soil temperature
- Off-set terminal heat stresses
- Minimizes unproductive loss of water through evaporation
- Cooling effect on plants (> 1°C) – terminal heat stress reduced
- Helps control weeds
- Improves soils quality
- Alternative for residue burning clean air
- Enhanced biodiversity
- Root penetration

Brown manuring

Extending resource use benefits

- Soil
- Water
- Nutrients
to enhance food availability and income and reduce cost

Relay cropping of wheat in cotton (farmer field)

Relay cropping in cotton vs. CP

Cotton Res. Instt., Faisalabad
Mungbean relay planting in wheat
Soil compaction with rotavator

- Rotavator Blade Actions

Rotavator actions - Rotavator has blades mounted on the rotor. These L shaped blades hit the soil surface at high speed (depending on machine RPMs > 700 times / min. The blade actions include:
  a. cutting a soil slice,
  b. Compacting and c. smearing actions as shown in the picture.

This creates a plow pan very close to the soil surface (16-20cm) depending upon the blade lengths.

CA and field economy in wheat (2020)

<table>
<thead>
<tr>
<th>CA Technology</th>
<th>Area (m. acres)</th>
<th>Fuel sav. (m. liters)</th>
<th>Water sav. (MAF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision leveling</td>
<td>18.3 (75%)</td>
<td></td>
<td>4.87</td>
</tr>
<tr>
<td>0-til planting</td>
<td>3.9 (50%)</td>
<td>84.6</td>
<td>0.52</td>
</tr>
<tr>
<td>Bed planting</td>
<td>12.2 (50%)</td>
<td></td>
<td>4.88</td>
</tr>
<tr>
<td>Relay cropping</td>
<td>4.2 (50%)</td>
<td>91.3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>24.45</td>
<td>175.9</td>
<td>8.6</td>
</tr>
</tbody>
</table>

CA benefits

Economic
- Time saving
- Reduced labor
- Reduced cost

Agronomic
- Organic matter buildup
- In-soil water conservation
- Soil structure improvement

Environmental
- Reduced erosion
- Improved water quality
- Improved air quality
- Biodiversity
- Carbon sequestration

Comparison of full and short season wheat varieties

Seed availability≈20%
- Local seed leaders
**YIELD LIMITING FACTORS**

- Late planting
- Imbalanced fertilizer use – means/price/availability
- Weeds infestation
- Shortage of canal water
- Lack of proper machinery
- Non availability of quality Seed
- Small holding size

---

**CSISA**

*Cereal System Initiative for South Asia*

- A joint project of **IRRI** and **CIMMYT**
- Operating in Bangladesh, India, Pakistan and Nepal
- Objectives – promote CA to fight climate change, poverty and hunger

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**Cereal Knowledge Bank**

[http://www.knowledgebank.irri.org/default.htm](http://www.knowledgebank.irri.org/default.htm)

Managed by:
- International Rice Research Institute (IRRI)
- International Maize and Wheat Improvement Center (CIMMYT)

---

**Country Knowledge Banks**: Bangladesh, Cambodia, China, India, Indonesia, Laos PDR, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Vietnam

**Extension**: Effective communication - Creation of extension materials - Needs and Opportunities Assessment - farm management - Training manual - Working with farmers

**E-Learning**: Biological Control of Insect Pests - Grain Quality - Water Management Course - Rice Breeding Course - Rice Production Course

**Acronyms and glossary of rice terminology**

---

**What do you find in CKB?**

- What the world is doing in cereals?
- Country Knowledge Banks
- Upload and download site
- Management factors at different growth stages
- Weed management strategies
- How to conserve the natural resources?
- How poor farmers can be uplifted to good growers?

---

**E-Learning Materials**

- Biological Control of Insect Pests
- English for Agriculture workers
- E-Learning for Development
- Grain Quality Course
- E-Water Management Course
- Rice Breeding Course
- Rice Production Course
Rice/wheat/maize
- Seed to Market
- Growth Stages
- Quality Seeds
- Agronomy
- Post Harvest
- Extras

Wheat Doctor
Rice Doctor
Maize Doctor

Additional sites
CSISA Knowledge Bank
http://www.knowledgebank.irri.org/csisa.htm
Hub Specific Knowledge Bank
http://www.knowledgebank.irri.org/csisabeta/index.php

Hub Communication Platform (HCP)
http://www.awhere.com/CSISA/Homepage.aspx
Combine effort of:
- CSISA
- Awhere Inc.

Weather Pin
- Maximum temperature
- Minimum temperature
- Precipitation
- Solar radiation
- Maximum daily wind
- Maximum morning wind
- Maximum relative humidity
- Minimum relative humidity

Local information
Plug in coordinates of a locality/field and
- Get previous 5 days met date
- 7 days forecast
- Likely insect/pathogen flare-ups
  - helps in planning field operations and plant protection measures
Pakistan AMAP- downloadable

Following information in map forms is available:
- Political (Admin, country)
- Demographic (populated places, urbanized points)
- Ecological (grass type, crop land, tundra and marshland)
- Hydrographic (water points, water courses and inland water)
- Infrastructure (airports, transportation, mines, pipelines, rail roads)
- Topographic (elevation points and contours)
- IWMclimate data (month wise precipitation, PET, min/max temperature)

Make maps - changes in water table depth

Per kg water use in selected crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Water Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kg wheat</td>
<td>1350 L</td>
</tr>
<tr>
<td>1 kg rice</td>
<td>3,000 – 5,000 L</td>
</tr>
<tr>
<td>1 kg maize</td>
<td>900 L</td>
</tr>
<tr>
<td>1 kg sugar cane</td>
<td>170 L</td>
</tr>
</tbody>
</table>

Thank you for your attention