Climate-smart agriculture in South Asia: Opportunities and constraints in scaling out

Pramod Aggarwal, Arun Khatri-Chettri, Shirsath P. Bhaskar, M.L. Jat* and P.K. Joshi**

CGIAR Research Program on Climate Change, Agriculture and Food Security, International Water Management Institute, New Delhi-110012, India
*CIMMYT, New Delhi-110012, India
**IFPRI, New Delhi-110012, India
South Asia: Home for 40% of World’s Poor

- > 1.6 billion people, 2.4% of the world’s land area and 17% of world’s population
- Still has high growth rate of population
- Tremendous progress in last 4 decades
  - Food consumption increased from 1900 kcals to > 2500 kcals
  - Average GDP growth >6%
  - Little food imports now
- Yet, 1/4th of the world’s hungry; 40% of the world’s malnourished children and women
- Lagging in MDGs
- Agriculture important for livelihood security of > 50% population
- Projected to be very vulnerable to climatic risks

Climatic stresses are common in South Asia
High CV of rainfall in Pakistan; northwest and south India

- Drought: 70% land
- Floods: 12% land
- Cyclones: 8% land
- Frost: Northern regions
- Heat: Frequent at many places
- Coastal salinity ingress
- One of the most vulnerable regions to climate change
- Food security and poverty are the key issues
Early signs of climate change: Rainfall trends in India for different seasons (1901-2003)
Different colors represent levels of significance

Source: IMD, 2010
Climate change and agriculture—South Asia is a major hotspot

- Climate change likely to reduce agricultural production by 10-50% by 2050 and beyond, if we do not start adapting now.
- Increased production variability due to more frequent droughts, floods, and heat events
- Large implications for intra- and inter-national trade.

Source: Erickson et al., 2012
Elevated tropospheric ozone can reduce the benefits of CO2 on crop yields (high confidence).

Interactions between CO2 and ozone, mean temperature, extremes, water and nitrogen are non-linear and not yet understood.

Source: IPCC-AR5 2014; Bhatia et al. 2015 personal comm
Agricultural emissions from the region

- Energy: 57.8%
- Agriculture: 17.6%
- Wastes: 3.0%
- Industry: 21.7%

More specific emissions sources and percentages:
- Manure management: 1%
- Enteric fermentation: 60%
- Crop residue burning: 2%
- Agricultural soils: 36%
- Rice cultivation: 21%
- Crop residue burning: 2%
Adapting South Asian Agriculture to Climate Change and Declining Resources: Need for CSA

- Increasing demand for (quality) food
- Increasing competition for resources
- Increasing degradation of resources
- Increasing climatic risks
- Increasing variability of global supplies, and prices
Addressing climate change and agriculture in South Asia
1. Make full use of untapped potential of currently available technologies

Invest in management of land and water resources, and input delivery and market linkage mechanisms
2. Identify and exploit potential benefits of climate change

- Change in temperature zones
- Increase in rainfall
- Shorter crop durations
- Shorter life cycle of fish
3. Improved climatic services
Scaling-out weather-based agro-advisories

Current status

- > 3 million farmers in India; pilots in other countries
- High dropout rate
- Generic advice; need to make this demand driven
- Cheap android phones; crowdsourcing and cloud computing could increase effectiveness and also facilitate scaling-out

Source: IMD and IKSL
3. Improved climatic services
Innovative crop Insurance schemes for improved management of climatic risks

• 30 million insured farmers in India; linked to credit; most are dissatisfied with products and services
• Pilots in other countries

Innovations needed
1. AEZ specific ‘indices’ for rainfall/temperature
2. MRV schemes managed by farming communities
3. Bundling crop insurance with other financial instruments and risk mitigating technologies
4. Improved models for delivery- PPP models
5. Direct benefits transfer: 110 million bank accounts in last 6 months
## 4: Maximize synergies among interventions

‘Climate-smartness’ of interventions

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Yield</th>
<th>CV</th>
<th>GHG emissions</th>
<th>Emission intensity</th>
<th>Investment</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher inputs</td>
<td>↑</td>
<td>?</td>
<td>↑</td>
<td>?</td>
<td>↑</td>
<td>↔</td>
</tr>
<tr>
<td>Zero tillage</td>
<td>↔</td>
<td>↓</td>
<td>↔</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Laser levelling</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Residue management</td>
<td>↑</td>
<td>↓</td>
<td>↔</td>
<td>↓</td>
<td>↔</td>
<td>↑</td>
</tr>
<tr>
<td>N sensors</td>
<td>↔</td>
<td>↔</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Tensiometers</td>
<td>↔</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↔</td>
<td>↑</td>
</tr>
<tr>
<td>Climatic services</td>
<td>↔</td>
<td>↔</td>
<td>?</td>
<td>?</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Crop insurance</td>
<td>↔</td>
<td>↔</td>
<td>↔</td>
<td>↔</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Climate-smart village</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>?</td>
<td>↑</td>
</tr>
</tbody>
</table>
Climate-smart villages: Integrated solutions leading to higher income, resilience, adaptation and mitigation

Several initiatives; top-down approach; lack of synergy among interventions; limited capacity of stakeholders

Strategy

- Integrated farmer participatory approach
- Builds on local knowledge and plans
- Precision agronomy principles: sensors
- Use of modern ICT tools
- Capacity strengthening and technology targeting

For more details visit www.ccafs.org
### Key Interventions in a Climate-Smart Village

#### CLIMATE SMART VILLAGE / FARM

<table>
<thead>
<tr>
<th>Weather smart</th>
<th>Water Smart</th>
<th>Carbon smart</th>
<th>Nitrogen smart</th>
<th>Energy Smart</th>
<th>Knowledge Smart</th>
</tr>
</thead>
</table>
| • Seasonal weather forecasts  
  • ICT based agro-advisories  
  • Index based insurance  
  • Climate analogues | • Aquifer recharge  
  • Rainwater harvesting  
  • Community management of water  
  • Laser leveling  
  • On-farm water management | • Agroforestry  
  • Conservation tillage  
  • Land use systems  
  • Livestock management | • Site specific nutrient management  
  • Precision fertilizers  
  • Catch cropping / legumes | • Biofuels  
  • Fuel efficient engines  
  • Residue management  
  • Minimum tillage  
  • Solar solutions for agriculture | • Farmer-farmer learning  
  • Farmer networks on adaptation technologies  
  • Seed & fodder banks  
  • Market info  
  • Off-farm risk management-kitchen garden |
### CSVs: Initial evidence from field

<table>
<thead>
<tr>
<th>Technology</th>
<th>Yield gain/loss (kg/ha)</th>
<th>Economic gains/loss (USD NR/ha)</th>
<th>Water saving (M3/ha)- for water smart practice</th>
<th>Energy Saving (MJ/ha)</th>
<th>Increase in NUE (as kg/kg)</th>
<th>Reduction in GHG (CO2-e kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero tillage in wheat (without residue)</td>
<td>342</td>
<td>131</td>
<td>414</td>
<td>3040</td>
<td>1.44</td>
<td>1507 (from LCA)</td>
</tr>
<tr>
<td>Zero tillage with residue in wheat</td>
<td>468</td>
<td>190</td>
<td>550</td>
<td>2650</td>
<td>1.61</td>
<td>?</td>
</tr>
<tr>
<td>Permanent beds in maize/wheat</td>
<td>195</td>
<td>289</td>
<td>1650</td>
<td>?</td>
<td>1.33</td>
<td>?</td>
</tr>
<tr>
<td>Direct seeded rice</td>
<td>±150</td>
<td>136</td>
<td>3000</td>
<td>?</td>
<td>-</td>
<td>420 (based on soil flux only)</td>
</tr>
<tr>
<td>Improved water management</td>
<td>375</td>
<td>97.51</td>
<td>405</td>
<td>?</td>
<td>1.40</td>
<td>-</td>
</tr>
<tr>
<td>Nutrient Expert in wheat</td>
<td>500</td>
<td>104</td>
<td>-</td>
<td>?</td>
<td>10</td>
<td>200</td>
</tr>
<tr>
<td>Laser leveling (RW system)</td>
<td>600</td>
<td>130</td>
<td>2500</td>
<td>?</td>
<td>?</td>
<td>330</td>
</tr>
</tbody>
</table>

Source: Jat et al. 2014
Climate-smart villages: ‘Growing’ solar power as a remunerative crop

Source: T. Shah, IWMI
Progress/plans on CSVs in South Asia

- Evidence base- Bihar, Haryana, Punjab and Maharashtra (India), plains of Nepal, southern Bangladesh
- Farmer to farmer communication- 200 villages in Bihar, 8000 women in Nepal
- Maharashtra Govt- 1000 villages, 100,000 farmers
- Nepal reaching 15000 rice, maize, sugarcane farmers, funded by IFC
- Bhutan: proposal to establish CSVs
- Linking with on-going government programs
5. Improved targeting of technologies and policies

What technologies and policies lighten the load for women in climate risk regions?
5. Improved targeting of technologies and policies: Do we need Seed banks to manage climatic risks?

1. Seed banks considered an important risk management/adaptation strategy
2. Costs and logistics involved are large
5. Improved targeting of technologies and policies: CSA-enabled development plans- Prioritizing interventions

- Builds from bottom-up biophysical and socio-economic datasets
- Spatially explicit, integrated modeling framework
- Addresses climatic and socio-economic scenarios
- Supports multi-objective trade-off analyses
- Supports more informed decision making
  - What crops to cultivate;
  - Which CSA technologies and practices to invest in;
  - Where to target that investment, and
  - When those investments should be made.
- NAPAs/ NAPs/NAMAs

![Diagram of spatial land units and socio-economic scenarios]
6: Address simultaneously poverty, governance, institutions, and human capital which limit agriculture growth even today

Poverty
Population at $2/day or less

Human capital
literacy rate

Green 1-10, Yellow 11-50, Red > 50
Conclusions: Scaling-out CSA: Key ingredients

1. Scaling-out CSA- challenges similar to intensification
   - **Good evidence base:** technology targeted for AEZs and farmer typologies – resources, priorities
   - **Impact pathway:** key actors, partners, R4D.
   - **Business models:** bundling interventions; institutional mechanisms: local govts; PPP
   - **Capacity strengthening** of key actors: farmers, industry, planners,....
   - **Policy support**

2. CSA has additional challenge since this is knowledge intensive
Increased investment in climate-smart agriculture will ensure global peace, equity and prosperity.