Advanced Technologies for Climate Smart Agriculture to Improve Food Security and Environmental Sustainability: Opportunities and Challenges for the Greater Mekong Subregion

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Situation

- To feed 9 billion people, we need to increase food production by 70% by 2050

- Most of the world poor depend on agriculture and agriculture will be most affected sector from climate change

- Agriculture key emitter of GHG emissions (around ¼) and driver of environmental degradation

Source: World Bank, 2019

How can we use advanced technologies to respond to such complex challenge?
Climate-Smart Agriculture (CSA)
the concept
What is Climate-Smart Agriculture .......

The Definition
“agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances achievement of national food security and development goals” (FAO)

The Pillars
1. Sustainably increasing agricultural **productivity** and incomes
2. **Adapting** and building resilience to climate change
3. Reducing and/or **removing greenhouse gases emissions**, where possible

The Tools
The CSA approach works to develop **technical**, **policy** and **investment** conditions which support sustainable agricultural development under climate change
CSA global synthesis
CSA Global Synthesis

- In 2018 CIAT prepared a **global synthesis paper** on the prevailing trends in CSA
- The report was based on the output of the **30 + CSA profiles** CIAT had conducted throughout the tropics
- **COP24**
The CSA Profile Series Now Covers over 30 Countries Globally

- **LAC**: 10 countries profiled, 68 production systems, 304 CSA practices
- **Africa**: 16 countries profiled, 157 production systems, 993 CSA practices
- **Asia**: 7 countries profiled, 65 production systems, 406 CSA practices

**Country profile key elements**

- Completed and available
- Currently in progress
- Under consideration for development
National agricultural context

**Economic dimension:** Agricultural context, value of agricultural exports & imports, etc.

**Social dimension:** Poverty, agricultural jobs & incomes, gender inequality, food & nutrition security, etc.

**Agri-environmental dimension:** Land use, agricultural input use, GHG emissions, etc.

Climate change and agriculture

**Projected changes in climate:**
- Estimated changes in mean annual temperature and total precipitation

**Economic impacts of climate change:**
- Potential changes in net trade, yields, crop area, and livestock numbers under different scenarios

CSA practices and technologies

**List of CSA interventions:**
- By production systems & agro-ecological zones (5-10 production systems, 3-5 practices each)

**Characteristics of CSA interventions:**
- Farm scale, adoption rates, barriers

**Climate-smartness assessment:**
- Climate-smartness scores across CSA pillars

Enabling environment for CSA

**Institutions for CSA:**
- CSA-related stakeholders, mandates & actions

**Policies for CSA:**
- State of policy action in support of CSA goals

**Finance in CSA:**
- Current and potential funding streams available for CSA

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**Smartness score**

**Productivity**
- **Yield**
  1. Yields
  2. Post-harvest loss
- **Income**
  3. Income/profit

**Adaptation**
- **Water**
  4. Agricultural water availability
  5. Water use efficiency
- **Soil**
  6. Soil disturbance (health)
- **Information**
  7. Climate risk management capacity
  8. Agricultural diversification
- **Gender**
  9. Labor intensity for women in agriculture

**Mitigation**
- **Energy**
  10. Energy use from fossil fuels
- **Carbon**
  11. Above ground biomass
  12. Below ground biomass
  13. Soil carbon stock
  14. Methane emission from livestock
- **Nitrogen**
  15. Nutrient use efficiency
Just five technologies groups account for ~50% of all practices considered climate-smart globally.

Technologies considered climate-smart are highly diverse. There is however a growing convergence on where and how CSA can make the biggest difference.
Insight 2: Climate-smartness is a function of context, not an innate property. The smartness of a given CSA technology can vary considerably between different production systems and locations.
Technologies considered climate-smart vary considerably across regions, reflecting the context-specificity of opportunities, constraints and agricultural sector characteristics around the world. Income and profit indicators were rated almost uniformly positive for all CSA technologies by experts.
Insight 4

Training and information were identified as the single largest barrier category to CSA adoption across all regions, affecting almost 90 percent of all interventions.

- Need to provide tailored information to farmers in a user centered way.
- Access to finance remains a key bottleneck & need to offer cheap options for farmers to try out.
- Lack of M&E and data on long-term impact and financial institutions do not factor in risk reduction.
- Agricultural support & subsidy are rarely supporting CSA.
CSA and Climate Action
Opportunities in the Greater Mekong Sub-region – Example of Vietnam
Smartness Assessment of CSA Practices

Key prioritized practices:
- Intercropping
- SRI/AWD
- Water saving
- Stress tolerant varieties

⇒ Important adaptation and productivity benefits but also mitigation
• 13 options with negative costs
• 64.9 MtCO$_2$eq at an average cost of -92.17 $/tCO$_2$eq
• **Key options**: agroforestry models in commercial crops, agriculture technologies like AWD, urea replacement and manure and diet management in livestock

⇒ Agriculture has potential to contribute to NDC at low costs
Environmental benefits of CSA?

Intercropping, e.g. maize – soybean

- Shift from monoculture to intercropping with nitrogen fixing crops (legumes as soybean) that convert atmospheric nitrogen to ammonium.
- Increase efficiency as the same yield can be obtained with less nitrogen fertilizers
- Higher soil fertility, increase in SOC
- **Reduced air pollution** ammonia emissions and lower fine particulate matters PM.2.5
- **Lower water eutrophication** from nitrogen fertilizers

➔ Nationwide adoption in China could save USD 13 billion/year from health costs (Ka Ming Fung et al., 2019)
Next opportunities to use advanced technologies for food security?
Climate services and digital agriculture for farm level tailored Ag Advisory
Climate Service Profiles

- Framework for mapping CS priorities for Agriculture with a bottom-up approach driven by demand
  - Assessing demand from different livelihoods/cropping systems
  - “knowledge network” analysis
  - Enabling environment and scaling opportunities
- Data collection in 4 countries across all agro-ecological zones (Cambodia, Lao PDR, Myanmar, Vietnam)
Data Driven Agronomy to develop actionable ag-advisories

Plot level outcomes (e.g. Risk to a pest/pathogen/Yields) is a complex interaction between:

- Climate
- Soil
- Management Practices

Uncontrollable factors

Controllable factors (farmers can change/optimize practices)

Plot level outcome (100%) (Yield/Pest and disease pressure)

**Data sources:** Time series climate (temperature, precipitation, solar radiation, relative humidity etc.) data from local weather stations, soil (soil types) from national databases, and crop management from geo-tagged farmer records

**Data mining:** Artificial neural networks to study relationships between pest/disease occurrence, climate, soil and crop management
Data Driven Agronomy that identified practices that can improve Maize yields in Cordoba (Argentina)

25 kg.ha\(^{-1}\) of phosphorus is a minimum to reach the full potential of the plants.

Shifting from manual harvest to combine harvester may improve yields by 100 kg.ha\(^{-1}\).

The plant density 20 days after emergence should be above 65000 plants.ha\(^{-1}\).
Problem: Localized advisory only possibly with existing farm level data

Solution: Need for digital solutions and incentives to build data lakes containing farm level data
AgriApp - for climate resilient production systems and bundling multiple services

**Pilot Status:** 40 rice smallholders are currently piloting the (fully loaded version) of the application in 2018 and 2019

On the front end of the application, farmer feeds in data relating to almost everything he/she does before, during and after the growing season.

On the backend, all the data is linked to stages/processes in a season which are further linked.

Generates multiple QR codes for different user needs.
AgriApp - for climate resilient production systems and bundling multiple services

Farmers provides traceability to buyer, the buyer uses this to sell the product at premium (short-term incentive)

AgriApp uses the data, deploys data analytics and pushes advisory information back on the same platform (long-term incentive)

New business opportunity from traceability services and ag advisory

Project Lead: CIAT
Technology Partner: rT Analytics
Funding from: GRET

Building a sustainable future
Emerging ecosystems of tech based solutions
Terra-i – Monitoring system for land use change

- Near real-time system for natural vegetation loss, producing maps every 16 days
- Monitor all types of vegetation across the tropics

**Pan-Tropical system**
- Tool detecting natural vegetation loss in the whole tropics
- Monitor all types of vegetation across the tropics
- Imagery spatial resolution: 6.25 Ha
- Based on MODIS MOD13Q1 product (vegetation index) and Global Precipitation Measurement (rainfall)

**National system**
- Tool detecting natural vegetation loss at local scale
- Imagery spatial resolution: 0.01 Ha
- Based on Sentinel 1 (SAR) Sentinel 2 (Optical) and Landsat 7 & 8 (Optical) and Global Precipitation Measurement (rainfall)
Near real time monitoring of forest change for quick action on the ground in Vietnam.

We are currently working with the government of Peru, Colombia, Honduras and Vietnam with potential project in the Philippines and Bolivia.

Technical staff from the forest protection department update the data every 2 weeks.

The new data are sent to the forest rangers in a understandable format for them.

The information is checked on the ground using drones and interviewing local communities.

The data collected is sent to the web platform and available as documentation of the change.
Challenges in the Great Mekong Subregion to scale digital agriculture

*Information and data quality*
- Awareness and access to information
- Lack of sufficient data to provide tailored advisory & quality of advisory inadequate

*Scaling models*
- Business model to incentivize data sharing and sell services to farmers or value chain actors not well developed
- Limited scaling out framework (policy, technology, capacity)
- Lack of necessary infrastructure (e.g. AWS for Climate Services)

*Social aspects*
- Digital divide increase inequalities
- Access to finance for some of the technologies (hardware, etc)
The way forward

• Fail fast, fail cheap & incentivize innovation

• Build capacity at all levels in accessing technology & increase digital literacy (smallholders, extension, government agencies, etc).

• Develop institutional support network and policy framework for digital agriculture and climate services

• Improve access to finance by de-risking agricultural finance (credits for solution increase resilience and risk-transfer mechanisms)

• Realign agricultural support to promote CSA & advanced technologies