T20 Policy Brief

Task Force 6
Accelerating SDGs

A DIGITALISATION ROADMAP FOR CLIMATE-SMART AGRICULTURE IN INDIA

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Abstract

Climate-smart agriculture requires a digital integration of climate and agriculture information. India is digitalising rapidly, and so its policies and practices to achieve climate-smart agriculture must also promote digital integration. This policy brief presents a framework and process guide to: (a) digitally integrate India's agriculture and climate information; (b) analyse India's extant agriculture and climate information policies within the framework; (c) highlight their strengths, weaknesses, and oversights; and (d) recommend pathways for the future. The brief will help determine the known effective pathways to climate-smart agriculture that must be reinforced, the known ineffective pathways that must be redirected, and the unknown new pathways that must be discovered and explored. It will thus develop a comprehensive roadmap for effective digitalisation pathways to climate-smart agriculture in India and other G20 countries, individually and collectively.

The Challenge

1

Climate-smart agriculture (CSA) is a part of India's and the G20 countries' Sustainable Development Goals (SDGs) vision. It is a complex, mega-scale challenge. The ontology of the digitalisation roadmap for CSA in India is a clear, concise, and comprehensive visualisation of the challenge, and a 'map' of the pathways to meet the challenge (see Figure 1[a]). The digitalisation of CSA can be understood as the integration of digital technologies in agri-food systems,[b] specifically related to the achievement of CSA goals.

The objective of CSA is to optimise a country's agriculture productivity, resilience, and emissions (Figure 1 – Outcome) in response to climate change (long-term, irreversible changes in temperature, precipitation, humidity, pressure, and wind; Figure 1 – Climate Change). The strategies must be specific to a country's different crops, namely cereals, pulses, oil seeds, fruits, vegetables, spices, fodder, and cash crops (Figure 1 – Crop). They must also be local to a country's agriculture regions (Figure 1 – Region) and their subregions.

CSA integrates knowledge about the agriculture effects of climate change in real time. It provides timely feedback and feedforward to policymakers and practitioners by sensing, monitoring, processing, translating, communicating, and archiving (Figure 1 – Function) the data, information, interpretation, and knowledge (Figure 1 – Semiotics). It learns and adapts.

a The ontology in Figure 1 has been developed based on the extensive experience of the authors and selected literature.

b Agri-food systems refer to the global food system, comprising the entire supply and value chain.

Figure 1: Ontology of the Digitalisation Roadmap for Climate Smart Agriculture in India

	Digital						Agriculture					
	Function		Semiotics		Climate Change		Crop		Region			
[Digital]	Sensing	[of]	Data	[about effects of]	Temperature	[change on]	Cereal	[Crop in the]	Eastern Himalayan	[region in India for effective agriculture]	Productivity	[Management]
	Monitoring		Information		Precipitation		Pulses		Western Himalayan		Resilience	
	Processing		Interpretation		Humidity		Oil seed		Lower Gangetic Plains		Emissions	
	Translating		Knowledge		Pressure		Fruit		Middle Gangetic Plains			
	Communicating				Wind		Vegetable		Upper Gangetic Plains			
	Archiving						Spices		Trans-Gangetic Plains			
							Fodder		Eastern Plateu and Hills			
							Cash		Central Plateau and Hills			
									Western Plateau and Hills			
									Southern Pleatue and Hils			
									East Coast Plains and Hills			
									West Coast and Ghat			
									Gujrat Plains and Hills			
									Western Dry			
									The Islands			

Source: Authors' own

The ontology encapsulates 43,200 (6*4*5*8*15*3) pathways for digital CSA. Each pathway is a concatenation of a word/phrase from each column of the ontology together with the adjacent connecting words/phrases. The pathways include, for example:

- The digital sensing of data about the effects of temperature change on cereal crops in the Eastern Himalayan region in India for effective agriculture productivity management.
- The digital processing of interpretation about the effects of wind speed changes on fodder crops in the southern plateau and hills region in India for effective agriculture emissions management.
- The digital communicating of knowledge about the effects of precipitation changes on spice crops in the eastern plateau and hills region in India for effective agriculture resilience management.

The challenge is to systematically discover and reinforce the known effective digital pathways to CSA, redirect the known ineffective pathways, and explore the unknown new pathways. There is currently no validated model to address this challenge.

The G20's Role in Addressing the Challenge

2

The G20 must play a key role in addressing the challenge of CSA by adopting the ontological framework, method, and recommendations to set the agenda for: (a) research, policy, and practice, and (b) the translation of research to policy to practice through feedback and learning. The G20 must constitute a committee to formulate a systemic agenda for systematic research, policies, and practices for the digitalisation of CSA in a country using the ontology. The Think20 Engagement Groups provide research and policy advice to the G20 and are ideal forums to develop the ontological framework as the G20 presidency rotates between the member countries each year. In addition to providing research-policy guidance through the task forces' policy briefs, these platforms could also engage experts who could facilitate the creation of country-specific ontological frameworks, and track progress using appropriate indicators.

There is no similar unified framework or concerted effort to address the challenge and provide a roadmap. The committee's agenda must inform and be informed by the constituent country (and local) agendas, and those of multilateral actors like the Food and Agriculture Organization and World Bank.

The ontology of CSA must be adopted globally as a framework for all G20 countries by adapting the crop and region taxonomies to each country. This can then be used as a global framework adapted to local requirements. Within the framework, each country can choose its pathways based on its local requirements, priorities, and resources. The adoption of a common framework will help formalise and transfer the knowledge about and feedback and learnings from the implementation within a country to across the G20 countries, and also the non-G20 countries. It will help transform the cycle of the generation and application of knowledge on the challenge from a selective, segmented, and siloed effort to a synoptic, systemic, and systematic one.

The framework must be used to periodically map the state of the research, need, and practice of CSA by a country. Analysing the gaps between the three will help guide the translation of research into policy and practice and then back to research, creating a virtuous feedback and learning cycle to achieve the SDG-3 vision (good health and well-being).

Thus, the G20 committee must help countries collaborate in their efforts, coordinate their policies, and communicate their learnings. It must set the trajectory for the digitalisation of CSA within the G20 and globally and must provide a 'map' for the global effort.

Recommendations to the G20

3

The following recommendations can guide the creation of agriculture digitalisation policies to address the key requirements for CSA in India. Such policies can also be generalised to other G20 countries and non-G20 countries. The recommendations are organised by the five dimensions of the ontology—outcome, region, crop, digital function, and digital semiotics. The climate change dimension is exogenous, and its effects must be understood and addressed by the policies.

Outcome Management

The ontology can be seen as an input-process-output model with three outcomes: productivity, resilience, and emissions. The three outcomes are both independent of and interdependent on each other. Consequently, there is always a trade-off between them that needs to be managed. For example, maximising productivity may reduce resilience and increase emissions. The global food system is a major contributor to greenhouse gas emissions. Harmonising the emissions outcome with those of productivity and emissions is part of the challenge of digitalising CSA. The potential policies are listed by the three outcomes.

Productivity

- Encourage the adoption of sustainable soil management practices such as organic farming, conservation tillage, and crop rotation through education and training programmes for farmers.

- Provide subsidies and financial incentives for the use of efficient irrigation techniques such as drip irrigation and rainwater harvesting.

- Invest in the research and development of improved seed varieties that are adapted to local growing conditions and are resistant to pests and diseases.

Resilience

- Promote crop diversification through the development of value chains for different crops and the provision of market infrastructure and support.

- Develop and implement a comprehensive risk management strategy that includes insurance products and financial support for farmers affected by climate-related disasters.

- Support the adoption of agroforestry practices through the provision of financial incentives, technical assistance, and extension services.

Emissions management

- Develop and implement policies that promote reduced tillage practices such as conservation tillage and no-till farming.

- Provide financial incentives and support for the adoption of renewable energy technologies such as solar, wind, and biomass energy.

- Develop and implement regulations and standards for sustainable livestock management practices, including reduced use of antibiotics and hormones, improved feed management, and manure management to reduce methane emissions.

- Develop and implement policies that reduce emission from practices such as crop residue burning.

Regional Management

It is essential to utilise digitalisation tools and technologies to effectively differentiate CSA management across regions in India. This can help in gathering real-time data and information on regional variations in climate, soil type and fertility, crop diversity and cropping patterns, landholding patterns and ownership, and socioeconomic conditions and access to resources.

Digital platforms can help in delivering customised and region-specific extension services to farmers, including weather forecasts, soil health reports, and crop advisories. This can enable farmers to adopt practices and technologies that are suitable for their unique agro-ecological and socioeconomic conditions. The use of digital tools such as sensors, drones, and satellite imaging can continue to help in optimising resource use and promoting precision agriculture.

Furthermore, digitalisation can also aid in stakeholder engagement and collaboration, bringing together farmers, policymakers, researchers, and other stakeholders to exchange knowledge and best practices. This can facilitate the development of region-specific policies and programmes that promote CSA practices and technologies.

In summary, digitalisation can play a crucial role in enabling the differentiation of CSA management across regions in India. It can aid in gathering and delivering region-specific data and information, promoting precision agriculture, and facilitating stakeholder engagement and collaboration. This can help in promoting practices and technologies that are suitable for the unique agro-ecological and socioeconomic conditions of each region.

Crop Management

To promote the effective use of digitalisation in climate-smart crop management, it is important to consider the following policy suggestions:

- Differentiation of CSA management across crops: This involves identifying the unique agro-ecological and socioeconomic conditions of each crop and designing region-specific policies and programmes that promote CSA practices and technologies. Digital platforms can help in delivering customised and crop-specific extension services to farmers, including weather forecasts, soil health reports, and crop advisories.

- Integration of CSA management across crops: This involves promoting the use of integrated crop management practices that focus on optimising resource use, reducing greenhouse gas emissions, and enhancing productivity across multiple crops. Digital tools such as sensors, drones, and satellite imaging can continue to help in optimising resource use and promoting precision agriculture, which can result in reduced input costs and increased yields.

- Precision crop management: This involves adopting precision agriculture techniques that utilise real-time data and information to optimise resource use and increase productivity. Digital technologies such as artificial intelligence, machine learning, and the Internet of Things can be leveraged to monitor crop health, soil moisture, and nutrient levels, and provide real-time recommendations to farmers.

Overall, the use of digitalisation in CSA crop management can help promote sustainable farming practices, optimise resource use, and increase productivity. Policymakers can encourage the adoption of digital technologies by providing incentives and support to farmers, promoting the development of digital infrastructure, and facilitating stakeholder engagement and collaboration.

Digital Semiotics Management

India can use data, information, interpretation, and knowledge of temperature, precipitation, humidity, pressure, and wind regime changes on crops in agriculture regions for effective crop productivity, resilience, and emissions in the following ways:

- Collect and analyse weather data: India has a vast network of weather stations across the country that collect data on temperature, precipitation, humidity, pressure, and wind fields. This data can be used to analyse weather patterns and identify trends that affect crop growth and yield. Machine learning algorithms can be used to process the data and provide real-time insights to farmers on weather forecasts, pest and disease outbreaks, and optimal planting and harvesting times.

- Develop crop-specific models: India has a diverse range of crops grown across different regions, each with unique requirements for temperature, precipitation, and other climatic factors. Crop-specific models can be developed using data and information on climate variability to predict crop yields, identify potential risks, and optimise resource use. These models can be integrated into digital platforms to provide farmers with tailored recommendations on crop management practices.

- Promote precision agriculture: Precision agriculture involves the use of digital technologies such as sensors, drones, and satellite imaging to monitor crop health and growth, and provide real-time recommendations to farmers. This approach can help optimise resource use, reduce greenhouse gas emissions, and enhance crop productivity. By incorporating weather data and information into precision agriculture technologies, farmers can make data-driven decisions that are tailored to the local climatic conditions.

- Build farmer capacity: To effectively use data and information on climate variability, farmers need to have the skills and knowledge to interpret and apply this information to their farming practices. Training programmes and extension services can be developed to build farmer capacity in using digital tools and interpreting weather data. These programmes can be designed to be accessible and affordable to all farmers, including smallholder farmers.

Overall, the effective use of data, information, interpretation, and knowledge of temperature, precipitation, humidity, pressure, and wind regime changes on crops in agriculture regions can help farmers in India to enhance crop productivity, resilience, and emissions management. By leveraging digital technologies and building farmer capacity, India can promote sustainable and climate-resilient agricultural practices that benefit both farmers and the environment.

Digital Functions Management

The digital functions of sensing, monitoring, processing, translating, communicating, and archiving are cyclical and ongoing. The ongoing cycles must provide the feedback and the feedforward necessary to achieve the outcomes efficiently and effectively. The feedback and feedforward loops must reinforce the correct trajectories of CSA and redirect the incorrect ones.

The infrastructure for and the governance of the digital functions must be motivated by legislative, economic, regulatory, fiscal/financial, informational, contractual, legal, and social policies. The object of these policies must be twofold: (a) to sustain the CSA informatic function cycle, and (b) to foster CSA informatics integration. The policies must seek to enhance the drivers of these to objectives, establish norms for their performance, and diminish the barriers to the same.

CSA Management

In summary, digitalisation can provide farmers and policymakers with access to real-time data, information, and knowledge; and it can improve decision-making, and support the effective implementation of policies to promote productivity, resilience, and emissions management in agriculture.

- Improved data collection and analysis: Digital technologies can enable the collection of accurate and real-time data on soil health, water availability, and climate conditions. This information can be used to develop targeted policies and interventions to promote productivity, resilience, and emissions management.

- Precision agriculture: Digital technologies such as satellite imaging, drones, and sensors can continue to help farmers optimise their use of resources such as water, fertilizers, and pesticides. This can help to increase productivity, reduce costs, and minimise environmental impacts.

- Access to market information: Digital platforms can provide farmers with real-time information on market prices, demand, and supply. This can help farmers make informed decisions on what crops to grow, when to sell, and at what price.

- Training and extension services: Digital platforms can be used to provide training and extension services to farmers on sustainable farming practices, risk management, and CSA.

- Monitoring and evaluation: Digital technologies can help policymakers monitor and evaluate the impact of policies and interventions on productivity, resilience, and emissions management. This can help to identify areas where further investment and support are needed.

Conclusion

4

The digitalisation of CSA requires a roadmap. This policy brief provides a clear, concise, and comprehensive framework to negotiate the labyrinth of pathways to CSA. The framework can be used for the governance of systems for digitalisation locally, nationally, and internationally. It can be the basis of learning CSA systems at all levels. Addressing the challenge of CSA is a prerequisite to meeting the challenge of food security, and digitalisation is essential to this task.

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