EAI Endorsed Transactions
on Energy Web

Research Article EAI.EU

Climate Smart Agriculture Practices in India

Manisha Singh[1*], Fatima Qasim Hasan [2]

[1] G. L. Bajaj Institute of Management and Research, Plot No. 2, Knowledge Park-III, Greater Noida-201306
[2] Galgotias University, Plot No. 2, Yamuna Expressway, Sector 17-A, Greater Noida-203201

Abstract

According to the World Bank, Climate-smart agriculture encompasses the comprehensive management of landscapes, including land under cultivation, livestock, woodland areas, and aquatic resources, addressing the interconnected issues of food security and climate change. United Nations Population Fund or UNFPAs Population dashboard shows India's population at 1406.6 million with an annual average rate of population increase at 0.9% from 2020-25. To meet this food demand, it is imperative for India to adapt sustainable agricultural practices. The IPCC (Inter-governmental panel on climate change) report has pointed out that climate change has affected food security due to global warming and extremes of temperatures around the World. In light of these facts, India faces the unique challenge of developing a path of enhancing the country's food supply, ensuring water availability while minimizing agricultural GHGs (Greenhouse emissions) which are estimated to be 14% of its total GHG emissions. In the 2021 Global Climate Risk Index (CRI), India was ranked 7th, with a CRI score of 16.67. This paper aims at understanding the theoretical and conceptual framework of climate smart agriculture and presents an insight into how the objectives of food sufficiency, change in climatic conditions and greenhouse gas emissions are being met in India through policies, institutions and financial models.

Keywords: Climate Smart Agriculture, Climate Change, Food Security, Sustainability, Resilience

Received on 09 October 2023, accepted on 12 December 2023, published on 19 December 2023

doi: 10.4108/ew.4645

*Corresponding author. Email: manisha.singh@glbimr.org

1. Introduction

According to the World Bank Climate-smart agriculture encompasses the comprehensive management of landscapes, including cropland, livestock, forests, and fisheries, to tackle the interrelated challenges of climate change & food security [1].According to FAO, these initiatives are founded on three fundamental pillars, namely: elevating productivity and income levels, bolstering the tenacity of livelihoods, and removing greenhouse gas emissions from the atmosphere.[2].These three pillars have synergies as well as trade-offs. The World Bank states that around 80% of the global population facing the highest risk of crop failures and hunger due to climate change resides in sub-Saharan Africa, South Asia, and South-East Asia. These regions are characterized by farming families that are disproportionately impoverished and vulnerable. [3] Climate-smart agriculture also has arisen as contemporary reaction to the urgent requirement for agricultural processes that can concurrently improve food security and support endeavours related to climate change mitigation and adaptation. [4]

United Nations Population Fund or UNFPAs Population dashboard shows India's population at 1406.6 million with an annual average rate of population increase at 0.9% from 2020-25[5] To meet this food demand it is imperative for India to adapt sustainable agricultural practices. The IPCC (Inter-governmental panel on climate change) report has pointed out that climate change has affected food security due to global warming and extremes of temperatures around the World [6]. In light of these facts, India faces the unique challenge of developing a path of enhancing the country's food supply, ensuring water availability while minimizing agricultural GHGs (Greenhouse emissions) which are estimated to be 14% of its total GHG emissions [7].

Climate smart agriculture is fully aligned with food security and compatible with economic profitability. Agriculture is much broader than production and it needs to be thought how we are addressing climate across value chains e.g. in trade and processing.

This paper is organized into four sections, with the first section serving as an introductory segment to the basic concept of Climate-Smart Agriculture; the second section provides a brief literature review and theoretical foundations of the concept of Climate Smart Agriculture (CSA). The third section presents the research methodology and objectives and proposes a conceptual framework of CSA. It also maps CSA practices implemented in India within the proposed conceptual framework. The fourth and last section concludes the study emphasizing the need for mainstreaming CSA in development planning for sustaining CSA practices in the future.

1.1 Literature Review

Climate Smart Agriculture (CSA) concept tackles the challenge of attaining food security, amidst climate change (FAO 2009, 2010; Lipper et al, 2014). Harvell, et al. have pointed to a co-movement of population and climate variability impacts on agriculture. [8] The concept of Climate-Smart Agriculture (CSA) has become a promising approach to ensure food security for the expanding global population in the face of global warming challenges. [9] The Food and Agriculture Organization (FAO) of the United Nations characterizes Climate-Smart Agriculture (CSA) as an approach to farming that bolsters resilience, boosts productivity, reduces greenhouse gas emissions, and actively works toward achieving national objectives of food security and sustainable development. [10]

Many nations have undertaken significant investments in agriculture, utilizing diverse climate adaptation projects with the goal of enhancing the productivity of smallholder farmers. These projects encompass initiatives such as the development of irrigation infrastructures and the dissemination of information regarding improved agricultural practices and packages. [11]. Regardless of this, focussing only on technology creation as automatically leading to a boost in agriculture has led to unfavourable results in most cases. This may be attributed to a failure to understand the circumstances under which farmers work and the intricacies of the organizational set-up [12]. Verhagen et al (2014) recognized 3 aspects of CSA idea viz. a) as process, b) as highly context-specific and c) multi-dimensionality. [13]. FAO has highlighted the role of institutional factors and financing mechanisms for better participation and increasing the use of climate-smart technologies and applications. It has also recognized the significance of combining agricultural finance with climate finance from both the public and private sectors as a critical factor in the successful implementation of Climate-Smart Agriculture (CSA).

A nation's manner to climate change concerns has a close relation with a country's growth. While for developed countries, alleviation is the priority, for developing countries, enhanced productiveness assumes more significance [14]. Many studies indicated that major hindrances to shifting towards the implementation of Climate-Smart Agriculture (CSA) technologies and practices were lack of appropriate policies, political support, the small shareholder farmer's lack of knowledge, and institutional and financial constraints [15] However, the transition from conventional practices to Climate-smart agriculture boosts economic returns[16]. A few benefits of CSA include improved soil fertility, increase in crop production, increased per capita nutrition consumption, and improved smallholder farmer's incomes, which are a contributing factor in reducing poverty. Therefore, it was suggested that CSA practices should be adopted globally.[17] Ehsan, Nusrat et al suggested that farmers should be trained and institutional services in the form of consultation should be provided which specifically focuses on climate-centric farming resulting in climate-smart agricultural practices for better food security [18]. To enhance the effectiveness of various Climate-Smart Agriculture Programs (CSAPs), the research suggests the need for efficient coordination among diverse stakeholders at the local level. This collaboration should engage farmers, agricultural institutions, service providers in agriculture, and governmental agencies. [19].

2. Objectives

The study is descriptive in nature and has the following objectives:

1) To construct a conceptual framework for integrating climate-smart agricultural practices in India, incorporating established definitions and dimensions of Climate-Smart Agriculture (CSA) drawn from previous studies.

2) To map current CSA practices in India with the stated conceptual framework and examine how far these practices are aligned with the proposed framework.

3. Methods

This study uses extensive literature studies mentioned above to derive a conceptual framework of climate smart agriculture practices. Further, it undertakes a rigorous study of Government policies, Institutions and available financing techniques in India using secondary data and discusses India's progress on these three supporting pillars.

3.1 Conceptual Framework

Irrespective of its definitions and dimensions, CSA necessitates the fulfilment of three key objectives which revolve around: i) Enhancing food security by raising productivity and incomes, ii) Adapting to the Challenges arising from climate change, and iii) Diminishing release of greenhouse gases when contrasted under a status quo or standard scenario, thus contributing to mitigation efforts. These goals are reinforced by the presence of climate-smart policies, Institutions geared towards climate resilience and financing mechanisms designed for climate adaptation. The overlapping areas of the three circles signify the synergies and trade-offs which are directly influenced by the policy, institutional and financing factors serving as enabling factors for CSA as represented below.

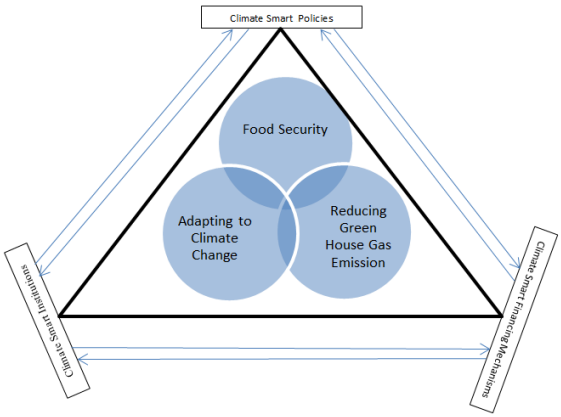

Figure 1: Conceptual Framework of CSA

Source: Adapted from "Collins-Sowah, Peron A. (2018): Theoretical conception of climate-smart agriculture, Working Papers of Agricultural Policy, No. WP2018-02, Kiel University, Department of Agricultural Economics, Chair of Agricultural Policy, Kiel"

3.2 Climate Smart Agriculture Policies in India

According to the Economic Survey 2020-21, agriculture mitigated the impact of the Covid-19 outbreak, as it accounted for 20% of GDP for the first time in 17 years. As per findings from McKinsey, the repercussions of climate change could potentially incur a $200 billion impact on India's GDP by 2030.[20].

The following practices have been successfully used in India, but they need to be scaled up further:

i) Farming with Zero Budget Natural Techniques

Farming with Zero Budget Natural Techniques is a chemical-free farming method which effectively eradicates the overall production and harvesting costs, as farmers recover their expenses through intercropping and other sustainable practices. It is a cross-sectoral strategy that affects natural resources, community health, nutrition, and women's empowerment. Evolving in Karnataka, it has been in practice in Andhra Pradesh where land productivity has increased [21]

ii) Private sector participation

The International Finance Corporation (IFC) emphasizes the necessity of highlighting the business aspects of Climate-Smart Agriculture (CSA) to encourage private sector engagement and facilitate the scaling up of CSA adaptation. In India, companies like Cargill Pvt Ltd, Kelloggs, PepsiCo, ITC have been promoting CSA practices in sourcing produce from the farmers.

iii) Farmers Producers Organization (FPOs)

Within the Farmer Producer Organization (FPO), farmers become members, functioning as producers of their agricultural products. These farmers have the opportunity to collectively incorporate themselves under the provisions of the Indian Companies Act. New guidelines for the establishment of Farmer Producer Organizations (FPOs) were released by the Ministry of Agriculture in 2020. This was done through three central agencies—"National Bank for Rural Development", "Small Farmers Agribusiness Consortium", and "National Cooperative Development Corporation", in collaboration with state regulatory bodies and the "National Agricultural Cooperative Marketing Federation of India".

iv) Weather index-based crop insurance

Short-term climate induced risk has been mitigated by schemes of Crop insurance. The "Pradhan Mantri Fasal Bima Yojana" and the "Integrated Agro-meteorological Advisory Service" have been instrumental in assisting farmers to optimize their earnings.

v) Digital climate advisory services (DCAS)

This includes diverse digital platforms such as online portals, mobile applications, and traditional yet digitally enhanced formats like radio broadcasts and interactive voice response systems. The availability of these services enabled through better networks and bundling have led to a rise in their adoption by farmers.

The following programmes have been implemented by the Government to promote CSA [23]

Table 1: Government Programmes promoting CSA in India

Government Programme	Climate- Smart	Energy- Smart	Nitrogen- Smart	Crop -Smart	Knowledge- Smart	Weather- Smart
"Pradhan Mantri Krishi Sinchai Yojana"	Drip- Irrigation				Capacity- Building	
	Conservation of water and					
	Irrigation Infrastructure					
"National Mission for Micro	Micro Irrigation					
National Mission for Sustainable	Rainfed Area Development		Soil health card			
"Rashtriya Krishi Vikas Yojana"	Micro Irrigation		Integrated Nutrient Management	Crop Diversification and Development		
	Natural Resource Management					
"National Food Security Mission"	Conservation Agriculture	Resource Conservation Machines	Integrated- Nutrient Management		Farmer's Training	
	Micro-Irrigation					
"National Mission for Horticulture"	Micro-Irrigation			Area Rejuvenation		
Renewable Power Programme		Solar Pump Sets				
on Agriculture Extension and Technology"		Farm Mechanization			improved agronomic- practices	
"Pradhan Mantri Fasal Bima Yojana"						Agriculture Insurance
"Weather Advisory"						Agro-Metrology

Source: Kishore, A., Pal, B. D., Joshi, K., and Aggarwal, P. K. (2018). "Unfolding Government Policies Towards India's Experience with Climate Smart Agriculture: Opportunities for Triangular Cooperation in the Indo-Pacific 88 Development of Climate Smart Agriculture in India." "Agricultural Economics Research Review, 31 (Conference Number), pp. 123–37"

3.3. Climate Smart Institutions in India

Governance involving good coordination and strong organizations is an important thrust area of Climate Smart Agriculture [24]. Private-Public partnerships attain significance in this context. Conducive policy environment and macro-economic stability encourage CSA [25] In India, the following Institutions are active in developing and delivering CSA related programmes:

i) "National Initiative in Climate Resilient Agriculture" (NICRA), New Delhi

With a robust climate change research infrastructure at many places in India, NICRA was established to undertake strategic research to improve resilience to climate change. At the "National Rice Research Institute" in Cuttack, Odisha, it has high throughput plant phenomics and emission reduction planting methods for rice.

ii) "National Institute for Rural Development and Panchayati Raj", Hyderabad

This stands as an autonomous and foremost institution for rural development. Through its Centre for Gender Studies and Development (CGSD), it is a knowledge leader in educating the trainers and scaling up gender-responsive governance.

iii) "National Institute of Agricultural Extension Management ", Hyderabad

This provides services across management, training, research and information services facilitating bi-lateral and multi-lateral programmes. More than 1400 extension officers from Asia and Africa have received training from them.

iv) "National Gender Resource Centre in Agriculture", New Delhi

This institution's mission is to promote gender equality in agriculture while effectively collaborating with other ministries and organisations.

Private Institutions include:

v) "The Energy and Resources Institute" (TERI), New Delhi

It offers advanced climate modelling and nano water solutions; TERI is an independent institution running many academic programmes along with consultancy and gender mainstreaming.

vi) CropIn, Bengaluru

Providing innovative farming solutions, CropIn works to ensure sustainability in agri-businesses.

vii) "Bharatiya Agro Industries Foundation" (BAIF), Pune

BAIF provides livelihoods to farmers through agriculture, horticulture and livestock development.

viii) "M S Swaminathan Research Foundation", Chennai

The MSSRF is dedicated to serving tribal and rural communities, and it works to include gender concerns in all of its initiatives and undertake research on climate, gender and institutions.

3.4 Climate Smart Financing in India

Small-scale farmers are not aware of the terminology of financial lending, plans and schedules. Farmers located in remote or interior areas find it difficult to access and visit Banks for loan requirements. Risks associated with climate change further aggravate their access to finance. Women farmers are particularly disadvantaged because of these factors. In response to these challenges, numerous innovative financial solutions have been introduced by both the Indian government and private sector entities. These solutions encompass:

i) Weather-based Insurance Products

IFFCO-Tokio Insurance has introduced a weather-index based crop insurance scheme.

ii) Warehouse Receipts

This stimulates scientific stocking of crops in a warehouse after harvesting. This warehouse serves as collateral in providing finance to farmers for addressing climate change concerns and encouraging sustainable development. In the fiscal year 2016-17, a climate change fund was established using the profits generated by NABARD.

iii) Carbon Finance

Carbon financing projects like Boomitra and carbon farming initiatives like the Sunderban Mangroves have shown good progress in India.

4. Results

The above programmes, institutions and finance models give good support to the overall goals of food security, climate change and curtailing the release of greenhouse gases. Yet, there is a necessity for embracing a comprehensive approach that accounts for interconnected factors and strategies to achieve desired outcomes benefiting all stakeholders within agricultural production systems. There is a need for mainstreaming climate change in development planning. In India, macro policy frameworks in the form of plans, policies and budgets need to be more inclusive of climate smart agriculture.

5. Conclusion and Future Direction

Building upon the preceding discussion, the following recommendations are proposed to fortify the conceptual framework for climate-smart agricultural practices in India:

Comprehensive Grasp of Climate Change Adaptation and Synergy

The primary mechanism for the current planning processes continue to rely on past events and are learning-based rather than being futuristic in terms of projected scenarios. This creates a time-gap and hinders our understanding of the complex interactions of the agricultural ecosystem of the future decades. Using real-time data analytics to predict future quality of soil, water and other resources is critical to address overlaps and align development programmes as required.

Budget Allocations

Finance gap may occur if a short-term funding approach is taken as, is the current scenario. System-based corrections need long time spans to work, and a 20-30 period financial planning horizon is the best way forward.

Alignment with SDGs

Goal No. 13 of SDGs calls for action to fight against climate change while Goal No.1 calls for ending poverty with 1.5 specifically calls for action to build strength of the poor and insulate them from extreme calamities.

Integrating Agriculture sector with technology

Adopting technology through digital platforms, artificial intelligence (AI), machine learning (ML), and the Internet of Things (IoT) is crucial for propelling sustainable and climate-resilient agricultural practices.

Embracing technology via digital platforms, artificial intelligence, machine learning, and the Internet of Things stands as imperative in advancing sustainable and climate-smart agricultural practices.

Scaling up CSA practices

Institutional frameworks involving local organizations, “Farmers Producers Organizations”, “Non-governmental Organizations”, “Self-help Groups” , “Community-based Organizations” , agricultural departments, agripreneurs, and the private sector can effectively be utilized to broaden the implementation of Climate-Smart Agriculture (CSA) practices.

References

1. https://www.worldbank.org/en/topic/climate-smart-agriculture
2. https://www.fao.org/3/an177e/an177e00.pdf
3. https://www.worldbank.org/en/news/feature/2022/10/17/what-you-need-to-know-about-food-security-and-climate-change
4. World Bank Group. Realigning Agricultural Support to Promote Climate-Smart Agriculture; World Bank Group: Washington, DC, USA, 2018.
5. https://www.unfpa.org/data/world-population-dashboard
6. Shukla PR, Skea J, Calvo Buendia E, Masson-Delmotte V, Pörtner HO, Roberts DC, Zhai P, Slade R, Connors S, Van Diemen R, Ferrat M.: IPCC, Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.
7. Haq,Z.: India aims for better practices to cut agri emissions, experts call for clear goals, https://www.hindustantimes.com/india-news/india-aims-for-better-practices-to-cut-agri-emissions-experts-call-for-clear-goals-101637068230083.html, last access 2023/09/24
8. Harvell, C.D.; Mitchell, C.E.; Ward, J.R.; Altizer, S.; Dobson, A.P.; Ostfeld, R.S.; Samuel, M.D.: Climate warming and disease risks for terrestrial and marine biota. Science.296. 2158–2162(2002). https://doi.org/10.1126/science.1063699
9. McCarthy, N.; Lipper, L.; Branca, G.: Climate-Smart Agriculture: Smallholder Adoption and Implications for Climate Change Adaptation and Mitigation; Climate Change Agriculture Work Paper. Food and Agriculture Organization of the United Nations (FAO), Rome (2011).
10. FAO, F.: Climate smart agriculture: policies, practices and financing for food security, adaptation and mitigation. *Food and Agriculture Organization, Rome* (2010).
11. Fernández-Baldor Á, Hueso A, Boni A.; From individuality to collectivity: The challenges for technology-oriented development projects. In

The capability approach, technology and design. Springer, Netherlands (2012).
12. Matta, N.F.; Ashkenas, R.N. Why good projects fail anyway. Harv. Bus. Rev. 2003, 81, 109–116. https://www.thechangeleaders.com/wpcontent/uploads/2019/01/HBR_-Why-Good-Projects-Fail-Anyway_Sep03.pdf. last accessed on 2023/01/09
13. Verhagen, J., Vellinga, T., Neijenhuis, F., Jarvis, T., Jackson, L., Caron, P., Torquebiau, E., Lipper, L., Fernandes, E., Mensa, REM, Vermeulen, Climate-Smart Agriculture - Scientists' perspectives. (2014) https://hdl.handle.net/10568/42434. last accessed on 2023/09/14
14. Steenwerth, K.L., Hodson, A.K., Bloom, A.J., Carter, M.R., Cattaneo, A., Chartres, C.J., Hatfield, J.L., Henry, K., Hopmans, J.W., Horwath, W.R.,Jenkins, B.M.: Climate-smart agriculture global research agenda: scientific basis for action. *Agriculture & Food Security*, *3*.1.1-39(2014). https://doi.org/10.1186/2048-7010-3-11
15. Wakweya, R.B.: Challenges and prospects of adopting climate-smart agricultural practices and technologies: Implications for food security. *Journal of Agriculture and Food Research*.100698(2023).https://doi.org/10.1016/j.jafr.2023.100698
16. Sarker, M.N.I., Hossain, B., Shi, G., Firdaus, and R.R.: Promoting net-zero economy through climate-smart agriculture: transition towards sustainability. Sustainability Science.18.5. 2107-2119(2023). https://doi.org/10.1007/s11625-023-01379-0
17. Tadesse, Benyam, Murad, Ahmed: Impact of adoption of climate smart agricultural practices to minimize production risk in Ethiopia: A systematic review; Journal of Agriculture and Food Research.100655(2023). https://doi.org/10.1016/j.jafr.2023.100655
18. Ehsan, N., Hoogenboom, G., Qamar, M.K., Wilkerson, C.J., Wajid, S.A. and Aziz, F.: Climate change risk perception and adaptation to climate smart agriculture are required to increase wheat production for food security. Italian Journal of Agronomy.17.4 (2022). https://doi.org/10.4081/ija.2022.2129
19. Akter, A., Mwalupaso, G. E., Wang, S., Jahan, M. S., Geng, X.: Towards climate action at farm-level: Distinguishing complements and substitutes among climate-smart agricultural practices (CSAPs) in flood prone areas. Climate Risk Management. 40.100491(2023). https://doi.org/10.1016/j.crm.2023.100491
20. Woetzel, J., Pinner, D., Samandari, H.: Climate risk and response: Physical hazards and socioeconomic impacts. Mc Kinsey & Company.
21. Vemuri, S.: Why Zero Budget Natural Farming is the Future of Sustainable Agriculture, https://qrius.com/zero-budget-natural-farming-future-sustainable-agriculture, last accessed 2023/09/15
22. Kanika, M.: What is FPO and How it is helpful to Farmers?, https://krishijagran.com/agripedia/what-is-fpo-and-how-it-is-helpful-to-farmers, last accessed 2023/09/17
23. Kishore, A., Pal, B.D., Joshi, K., Aggarwal, P. K.: Unfolding Government Policies Towards the India's Experience with Climate Smart Agriculture: Opportunities for Triangular Cooperation in the Indo-Pacific 88 Development of Climate Smart Agriculture in India. Agricultural Economics Research Review.31. 123–37(2018). http://dx.doi.org/10.5958/0974-0279.2018.00028.9
24. Lipper, L., Zilberman, D.: A Short History of the Evolution of the Climate Smart Agriculture Approach and Its Links to Climate Change and Sustainable Agriculture Debates. Springer International Publishing, Cham. 13-30 (2018). DOI 10.1007/978-3-319-61194-5
25. Ehui, S., Pender, J.: Resource degradation, low agricultural productivity, and poverty in sub-Saharan Africa: pathways out of the spiral. Agricultural Economics. 32(s1), 225–242 (2005). https://doi.org/10.1111/j.0169-5150.2004.00026.x