India & G20: Climate-Smart Agriculture

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ABSTRACT

This paper attempts to analyze the changing nature of agriculture and its greater inclination towards digitized means in the upcoming future, focusing on India among the various G20 countries. The research aims to portray the fact that digital integration to achieve climate-smart agriculture (CSA) is in vogue today. The need for a sustainable and inclusive system of agriculture has strengthened over the years, and a general consensus by various countries has given way to the digital medium as the transformative tool to promote efficient agriculture. The paper thus includes how CSA is the new future, what it aims to achieve along with the challenges it currently faces. The paper also attempts to throw light on the current policy changes being worked upon in the said field while simultaneously recommending pathways for future development through means like providing farmers with specialized, region-specific extension services, introduction of digital semiotics using machine learning algorithms, utilizing tools like sensors, drones, and satellite images to keep a track on the crop and work on productivity issues etc.

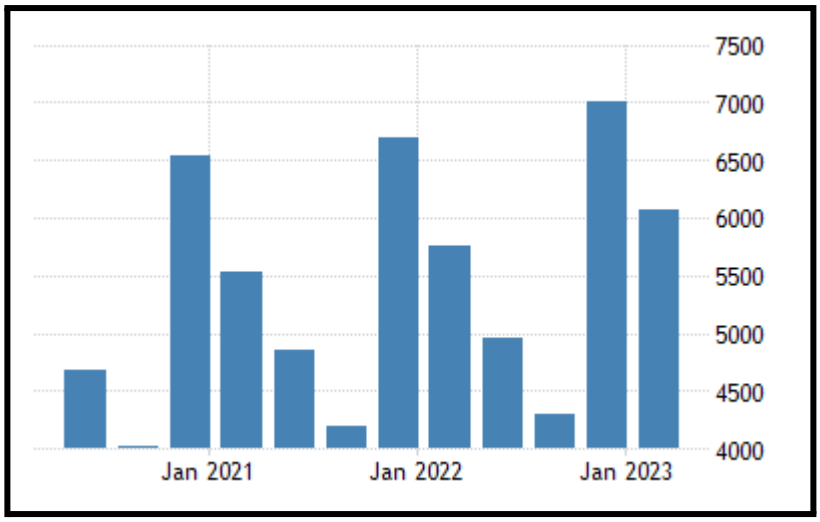
INTRODUCTION

"Give water to the farmers of this country and see the wonders they can do. Through the Pradhanmantri Krishi Sinchai Yojana, we want to ensure that water reaches every village across the length and breadth of the country." –PM Modi at Limkheda, Gujarat, 2016

Agriculture plays a very important role in India, both socially and economically. It is often described as the backbone of the Indian economy. Today, agriculture majorly restricts itself to rural India, however, it is still the occupation of about 54.6 % of the Indian workforce and contributes 17.8 % to GDP of the nation[1]. The traditional procedures followed in this field have restricted the potential of both the farmers and their production. These methods often succumb to problems like limited irrigation. It is often found with traditional agriculture that systems are not set up to ideally distribute; most of the water used does not get absorbed by crops but evaporates. Also, it kills off life in the topsoil and subsoil. It tends to leech the land of its nutrition over time resulting in soil that is undernourished and eroded. There are other variables too, on which one has no control. A major factor, when it comes to conventional farming, is crop exposure to the elements. Crops are heavily affected by things like sunlight, rain, and wind, and there is only so much that farmers can do to control the impact of these elements. It is also not uncommon to hear about the difficulties that the farmers go through because of

[1] Annual Report 2020-21

these factors.

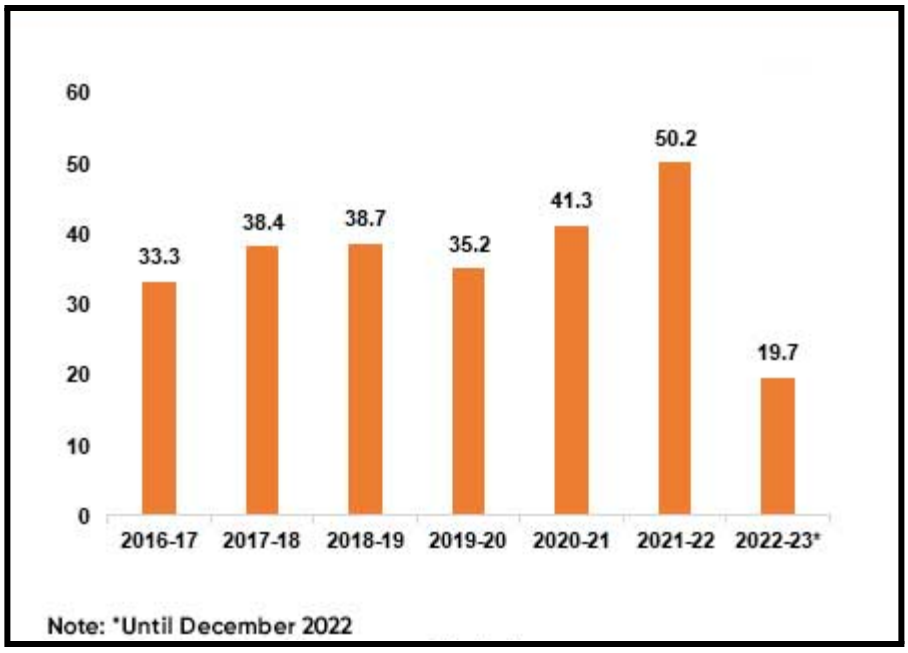


[2]

GDP from agriculture over the years

Digitalisation as a method offers the possibility to help address the productivity, sustainability and resilience challenges facing agriculture. Through digitalisation of agriculture, we introduce cutting-edge, integrated digital technology into the farm production system, including AI, robotics, uncrewed aviation systems, sensors, and communication networks. It helps farmers increase yield by assisting them in choosing better crops, hybrid seeds, and resource-efficient farming techniques. It is also utilized to improve farming productivity and accuracy to assist farmers in creating seasonal forecasting models. Taking this digital approach forward, Climate-Smart Agriculture (CSA) as a part of India's and the G20 countries' SDGs vision aims to optimize a country's agricultural productivity, resilience, and emissions in response to climate change (long-term, irreversible changes in temperature, precipitation, humidity, pressure, and wind).

[2] GDP from Agriculture - Trading Economics



[3]

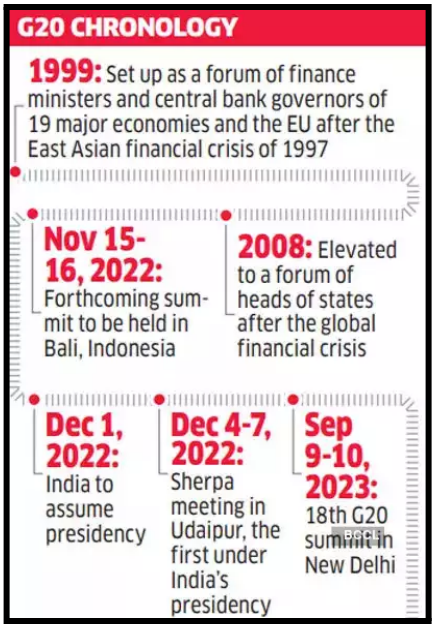
India's agriculture exports trend (US billion dollars)

G20 :

HISTORICAL CANVAS

The Group of 20 (G20) was founded in 1999 after the Asian financial crisis as a forum for the Finance Ministers and Central Bank Governors to discuss global economic and financial issues. It plays an important role in shaping and strengthening global architecture and governance on all major international economic issues. The G20 members represent around 85% of the global GDP, over 75% of the global trade, and about two-thirds of the world population. Bilateral meetings on the summit's sidelines have occasionally led to major international agreements. The previous 17 Presidencies of the G20 delivered significant results — for ensuring macro-economic stability, rationalizing international taxation, relieving debt-burden on countries, among many other outcomes. These summits have addressed topics like the COVID-19 pandemic, 2008 financial crisis, the Iranian nuclear program, and the Syrian civil war.

[3] India's agriculture exports trend - The Ministry of Commerce and Industry



[4]

INDIA'S PRESIDENTIAL NARRATIVE

"Peace, unity and harmony are useful in family, life, society and for the nation. And to all those who believe in Vasudhaive Kutumbakam, the whole world is one." -PM Modi in an interview to Network18, Nov 14, 2022

December 1st, 2022 was a momentous day as India assumed the presidency of the G20 forum, taking over from Indonesia. As the largest democracy in the world, and the fastest growing economy, India's G20 presidency planned to play a crucial role in building upon the significant achievements of the previous 17 presidencies. India holds the Presidency of the G20 from 1 December 2022 to 30 November 2023. India's G20 Presidency will work to promote the universal sense of one-ness. India has set "Vasudhaiva Kutumbakam" or "One Earth - One Family - One Future" as the theme for its G20 Presidency, rightly aiming to instill a sense of unanimity essential for addressing these global challenges collectively and effectively. The theme also exemplifies LiFE (Lifestyle for Environment), which highlights the importance of environmentally sustainable and responsible lifestyle choices, both at the individual and national level, in creating a cleaner, greener, and bluer future. Prime Minister Narendra Modi further envisions India's G20 agenda to be "inclusive, ambitious, action-oriented, and decisive." India's successes and experiences are critical to tailoring global solutions.

[4] G20 Chronology - The Economic Times

INDIA'S G20 PRIORITIES:

- **Green Development, Climate Finance & LiFE** - India's focus on climate change, with a particular emphasis on climate finance and technology, as well as ensuring just energy transitions for developing countries. Introduction of the LiFE movement, which promotes environmentally-conscious practices and is based on India's sustainable traditions.
- **Accelerated, Inclusive & Resilient Growth** - Focus on areas that have the potential to bring structural transformation, including supporting small and medium-sized enterprises in global trade, promoting labor rights and welfare, addressing the global skills gap, and building inclusive agricultural value chains and food systems.
- **Accelerating Progress on SDGs** - Recommitment to achieving the targets set out in the 2030 Agenda for Sustainable Development, with a particular focus on addressing the impact of the COVID-19 pandemic.
- **Technological Transformation & Digital Public Infrastructure** - Promotion of a human-centric approach to technology and increased knowledge-sharing in areas such as digital public infrastructure, financial inclusion, and tech-enabled development in sectors such as agriculture and education.
- **Multilateral Institutions for the 21st century** - Efforts to reform multilateralism and create a more accountable, inclusive, and representative international system that is fit for addressing 21st century challenges.
- **Women-led Development** - Efforts to reform multilateralism and create a more accountable, inclusive, and representative international system that is fit for addressing 21st century challenges.

CLIMATE SMART AGRICULTURE AS THE NEW FUTURE

The G20 leaders stressed on the need to increase climate finance to help farmers take up innovative measures in order to mitigate the climate change impact on the farm sector. The agricultural secretary, Mr. Manoj Ahuja, on the concluding day of the G20 first Agriculture Deputies' Meeting said: "*Climate finance was one of the issues which was discussed. The members felt that there was a need for an environment for increasing climate financing in terms of financing farmers for adaptation measures.*" **Climate smart agriculture** was one of the four priority areas discussed in this meeting.

- **MEANING AND REASON TO PROMOTE**

  Climate Smart Agriculture (CSA) is an integrated approach to manage landscapes, address

food security and climate change. It aims to decrease trade-offs and encourage synergies in agricultural and livestock systems, forests, and fisheries and aquaculture to make them more productive and sustainable. Most of the world's impoverished reside in rural areas, where agriculture is their primary source of income. The key to ensuring global food security over the next twenty years will be developing the potential to raise the productivity and incomes from smallholder crop, livestock, fish, and forest production systems.

- **AIMS**

It focuses on the sustainable agricultural practices that help to increase food production and farmer incomes, improve resilience to climate change, and reduce greenhouse gas emissions.

1. Increased productivity: Produce more and better food to improve nutrition security and boost incomes, especially of 75 % of the world's poor who live in rural areas and mainly rely on agriculture for their livelihoods.
2. Enhanced resilience: Reduce vulnerability to drought, pests, diseases and other climate-related risks and shocks; and improve capacity to adapt and grow in the face of longer-term stresses like shortened seasons and erratic weather patterns.
3. Reduced emissions: Pursue lower emissions for each calorie or kilo of food produced, avoid deforestation from agriculture and identify ways to absorb carbon out of the atmosphere.

- **G20's ROLE**

1. By embracing the ontological framework, method, and recommendations to set the agenda for research, policy, and practice, the G20 must play a significant role in tackling the challenge of CSA. Taking into consideration the fact that the G20 presidency alternates annually among the member nations, the Think20 Engagement Groups are the best venues for developing the ontological framework. They offer research and policy advice to the G20. These platforms could also work with experts who could help with the facilitation of the building of country-specific ontological frameworks in addition to giving research-policy assistance through the task forces' policy briefs.

2. There isn't a comparable cohesive framework or coordinated effort to address the issue and offer a strategy. The objectives of the member countries (and local governments), as well as those of multilateral organizations like the Food and Agriculture Organisation and the World Bank, must inform and be informed by the committee's agenda.
3. Periodically mapping the state of CSA research, need, and practice by a nation is required using the framework. In order to realize the SDG-3 goal (excellent health and well-being), analyzing the gaps between the three will assist direct the translation of research into policy and practice, and then back to research. Therefore, the G20 committee must assist nations by giving a "map" for the global effort and define the course for the G20 and worldwide digitalization of CSA.

- **CHALLENGES**

1. **Complex and Multidimensional:** CSA is a complicated and multi-dimensional challenge that calls for integrated solutions, some of which may be challenging to put into practise and necessitate substantial investments. The successful uptake of CSA is also constrained by socio-economic issues, even when policies are suitable and finance is adequate. Adopting sustainable agriculture practices can frequently be challenging due to a lack of clear land or tree ownership for smallholder farmers.
2. **Lack of Awareness and Expertise:** Many farmers may not be knowledgeable enough to execute CSAs successfully and may not be aware of the advantages of them. They may lack explicit legal guidance to the population regarding protected areas and protection infrastructure such as erosion control, terraces, and enclosed places, and the widespread implementation of CSA.
3. **Access to Finance:** Financing for CSA practices may be difficult to come by, especially for smallholder farmers who do not have access to credit or collateral. CSA practices and technologies involve transitioning to high-productivity, intensive, healthy, justifiable, and low-emission agriculture. However, there is a need for careful selection of production systems, adoption of approved procedures, and use of appropriate breeds to help to get significant profit.
4. **Policy and Institutional Constraints:** Institutions and policies may not be in line to promote the adoption and expansion of CSA practices. The lack of proper policies and political commitment is one of the main challenges for CSA expansion.
5. **Technical and Technological Challenges:** CSA requires the use of appropriate technologies and practices, which may not be available or accessible in some regions. Countries need support in developing regulatory, institutional mechanisms to integrate environmental problems into the agricultural sector and provide a foundation for operationalizing sustainable agriculture and food systems in changing environments.

6. **Climate change impacts:** The impacts of climate change, such as droughts, floods, and other extreme weather events, may negatively affect the productivity and resilience of agricultural systems, making it difficult to implement CSA practices.
7. **Data and information gaps:** There may be limitations in data and information on the impacts of CSA practices, making it difficult to measure their effectiveness and scale them up.

CLIMATE SMART AGRICULTURE AND THE WORLD BANK GROUP

Climate-smart agriculture is now being expanded by the World Bank Group (WBG). The World Bank committed to collaborating with nations to produce climate-smart agriculture that achieves the triple win of higher production, enhanced resilience, and reduced emissions in its first Climate Change Action Plan (2016-2020) and the upcoming update spanning 2021–2025. 52 % of World Bank funding for agriculture in 2020 has climate adaptation and mitigation as a goal.

The WBG portfolio also intends to rebalance to place more emphasis on adaptation and resilience and strengthen its focus on impact at scale. They are assessing all projects for climate risks in order to fulfill their pledges, and they'll keep creating and using metrics and indicators to gauge success and take into consideration greenhouse gas emissions in their operations and initiatives. These initiatives will aid the client nations in carrying out their Nationally Determined Contributions (NDCs) in the agricultural sector and advance the Sustainable Development Goals (SDGs) for combating climate change, ending poverty, and ending hunger.
Additionally, the World Bank Group supports research initiatives like the CGIAR (Consultative Group on International Agricultural Research), which creates resilient technologies, early warning systems, risk insurance, and other innovations to combat climate change.

INDIA : THE CURRENT CSA APPROACH

India is digitizing rapidly, and so its policies and practices to achieve climate-smart agriculture must also promote digital integration. India's current CSA policy aims to digitally integrate India's agriculture and climate information, analyze India's extant agriculture and climate information policies within the framework, highlight their strengths, weaknesses, and oversights and recommend pathways for the future.

The following are some components of climate-smart agricultural systems:

- Management of farms, crops, livestock, aquaculture, and catch fisheries to strike a balance between priority for adaptation and mitigation and demands for near-term food security and livelihoods.
- Management of ecosystems and landscapes to preserve ecosystem services vital to food security, agricultural growth, adaptation, and mitigation.
- Services for farmers and land managers to help them manage risks/impacts of climate change and mitigation measures better.
- Alterations to the larger food system, including demand-side initiatives and value chain interventions, can increase the advantages of CSA.

The CSA Approach can be implemented through the following actions:

1. **Expanding the evidence base:** The evidence base consists of the consequences of climate change on a country's present and future, the identification of critical agricultural sector vulnerabilities and for food security, and the identification of efficient adaptation strategies. Estimates of the potential greenhouse gas emissions reduction (or increased carbon sequestration) brought on by adaptation strategies are included, as well as data on the costs and obstacles to adopting various practices, concerns about the sustainability of production systems, and the necessary institutional and policy responses to address these concerns.
2. **Supporting enabling policy frameworks:** The strategy facilitates the creation of pertinent policies, strategies, investments, and coordination between the procedures and institutions in charge of land use, agriculture, and climate change.
3. **Strengthening national and local institutions:** Strong local institutions are necessary to empower, facilitate, and inspire farmers. In some instances, there may also be a need to strengthen local government officials' relationships to national policy makers and increase their capacity to participate in international policy fora on climate change and agriculture.
4. **Enhancing financing options:** A crucial component of CSA implementation is the use of

creative financing methods that combine public and private sector investments in agriculture, climate change, and finance. The creation of new climate financing tools, like the Green Climate Fund, could help promote the expansion of sustainable agriculture. **National Adaptation Plans (NAPs)** and strong, comprehensive **Nationally Appropriate Mitigation Actions (NAMAs)** are crucial national policy instruments for establishing connections to domestic and international sources of funding. Since national sector budgets and ODA will still serve as the primary financing sources, integrating climate change into sector planning and budgeting is necessary to successfully combating climate change.

5. **Implementing practices at field level:** Farmers are the main keepers of knowledge about their local climatic patterns, agro-ecosystems, crops, and livestock. The knowledge, needs, and priorities of nearby farms must be taken into consideration when adjusting to CSA. Local initiatives and organizations assist farmers in locating acceptable, easily adoptable, climate-smart choices.

KEY GOVERNMENT INITIATIVES

INITIATIVE	DESCRIPTION
National Innovations in Climate Resilient Agriculture (NICRA)	A network project launched by the Indian Council of Agricultural Research (ICAR) in 2011 to enhance resilience of Indian agriculture to climate change
Soil Health Card Scheme	Launched in 2015 to provide farmers with information on the nutrient status of their soil and recommend appropriate soil health management practices
Pradhan Mantri Fasal Bima Yojana	Launched in 2016 to provide farmers with insurance coverage and financial support in the event of crop losses due to adverse weather conditions
Paramparagat Krishi Vikas Yojana	Launched in 2015 to promote organic farming practices in India and reduce the use of chemical fertilizers and pesticides
National Mission for Sustainable Agriculture (NMSA)	Launched in 2010 to promote sustainable agriculture practices in India and enhance agricultural productivity and income of farmers
Rashtriya Krishi Vikas Yojana	Launched in 2007 to support agricultural development in India through the provision of financial assistance for various agricultural activities
National Agriculture Market (e-NAM)	Launched in 2016 to create a unified national market for agricultural commodities in India through the use of technology and digital platforms
Kisan Credit Card Scheme	Launched in 1998 to provide farmers with access to affordable credit for agricultural and related activities
Pradhan Mantri Krishi Sinchai Yojana	Launched in 2015 to promote efficient use of water resources in agriculture and enhance water use efficiency in farming

LINKAGE TO PROMOTION OF CSA

GOVT PLAN	WATER SMART	ENERGY SMART	NITROGEN SMART	CROP SMART	KNOWLEDGE SMART
Pradhan Mantri Krishi Sinchai Yojana	1. Micro irrigation (drip and sprinkler) 2. Water conservation and harvesting 3. Irrigation infrastructure through MGNREGA)				Capacity Building
National Mission for Sustainable Agriculture (NMSA)	On-farm water management 2014–2015 Rainfed area development		Soil health card and management		
Rashtriya Krishi Vikas Yojna	1. Micro irrigation 2. Natural resource management		Integrated nutrient management	Crop diversification and development	
National Food Security Mission	1. Conservation Agriculture 2. Micro irrigation	Resource conservation machines	Integrated nutrient management		Farmers' training
National Mission on Agriculture Extension and Technology		Farm mechanization			Training on improved agronomic practices

MAJOR GOVERNMENT INITIATIVES

<u>According to the Ministry of Agriculture, the government has taken various smart agriculture initiatives such as:</u>

- **<u>Artificial intelligence (AI)-based crop yield prediction model:</u>** In 2018, the **NITI Aayog** collaborated with **International Business Machine (IBM)** to develop an AI-based agricultural yield prediction model. This aids in giving farmers advice in real time. It is ideal for crop yield prediction because it can identify patterns and relationships in large amounts of data and make predictions based on these relationships. There are various types of machine learning algorithms that can be used for crop yield prediction including :
    - ➔ **Regression** algorithms are commonly used for predicting crop yields because they are simple to understand and easy to implement. These algorithms use a set of inputs (such as weather data, soil data, and management practices) to predict the output (crop yield).
    - ➔ **Decision tree** algorithms are also used for crop yield prediction. The algorithm starts by making a decision based on the most important input factor and then continues to make additional decisions based on subsequent inputs. The final result of the algorithm is a prediction of crop yield.
    - ➔ **Artificial neural networks** are a more complex type of machine learning algorithm particularly well suited for crop yield prediction because they can handle large amounts of data and identify complex patterns and relationships.

- **<u>AI sensors for smart farming:</u>** With Microsoft's assistance, India has started giving smallholder farmers more power. To build an ecosystem for employing AI in farming, it is collaborating with farmers, state governments, the **Ministry of Electronics and Information Technology**, and the **Ministry of Agriculture and Farmers Welfare.** The alliance aims to boost farmers' incomes through improved price management and increased agricultural yield using AI sensors. The collaboration would accelerate the use of AI in farming. The Indian government invested 1756.3 crore rupees and 2422.7 crore rupees during 2020-21 and 2021-22 respectively in new technologies like remote sensing, blockchain, drones, and GIS.
    - ➔ An AI Sowing App powered by the Microsoft Cortana Intelligence Suite, which includes Machine Learning and Power BI, was developed by Microsoft in partnership with **ICRISAT** (International Crops Research Institute for the Semi-Arid Tropics). Participating farmers receive seeding advice from the app regarding the best time to

sow. The best feature of the programme is that farmers may use it without having to invest funds or install sensors in their farms. All they require is a feature phone with text message capability.

- ➔ The **Moisture Adequacy Index** (MAI) is computed to estimate the ideal sowing season. The standardized method known as MAI is used to evaluate how well rainfall and soil moisture meet the prospective water needs of crops. The daily rainfall data is used to generate the real-time MAI.
- ➔ The largest agrochemical manufacturer in India, United Phosphorus (UPL), and Microsoft have worked together to develop the **Pest Risk Prediction** interface, which likewise makes use of AI and machine learning to predict the likelihood of a pest assault in advance. With the use of this instrument, farmers will be able to cut down on crop loss brought on by pests, which will increase their farm income by double.

- **Drones to monitor crop and soil health:** Six institutes are participating in the government's **Sensor-based Smart Agriculture (SENSAGRI)** project. Drones would be utilized in this concept to easily scout over land areas, acquire priceless information, and instantly communicate the data to farmers. The **Ministry of Communication and Information Technology (MCIT), the Department of Electronics and Information Technology (DEITY), the Information Technology Research Academy (ITRA), and the Indian Council of Agricultural Research (ICAR)** are among the organizations that will provide funding for the project. On 19th March 2022, PM Narendra Modi introduced 100 drones that would help farmers through weather predictions. According to other sources, rainfall research, soil reports, insect infections, and drone imagery can be used for crop monitoring, field surveys, and in-depth field analysis; while remote sensing, proximity sensing, image-based precision farming, and Internet of Things (IoT) can be utilized for data integration in regards to historical meteorology. Identifying patterns in voluminous datasets through yield mapping and optimizing irrigation systems is indispensable for crop planning.

IMPACT OF POLICIES IMPLEMENTED

- Under **National Innovation on Climate Resilient Agriculture (NICRA)**, cutting-edge climate change research facilities have been constructed at numerous institutes across the nation. These facilities have helped develop climate resilient solutions for a variety of crops. The vulnerability of Indian agriculture to climate change has been assessed at the district level (572 rural districts). For 650 districts in India, Indian Council of Agricultural Research (ICAR) and **National Agricultural Research System (NARS)** have created District

Agriculture Contingency Plans, which are continually updated.Under the NICRA Project, climate-resilient communities have been created, one in each of 151 climatically susceptible districts, and location-specific technologies have been tested there.

- In India's total water utilization plan, the slogan "More crop per drop" is a powerful one. In addition to MGNREGA, the **Prime Minister Krishi Sinchayee Yojana (PMSKY)** has made a significant contribution to the nation's ground water recharging and use. Within PMSKY is a Micro Irrigation Fund with a focus on climatically sensitive solutions for protective irrigation and water use efficiency.
- India's fertilizer policy has improved crop production and productivity, which has resulted in growth. 13.66 Mt more of food grain was produced using fertilizers as a result, preventing the conversion of 11.48 million hectares (MHa) of forest area to farmland and lowering 2013 MHA of GHG emissions. In addition, neem coated urea has enhanced nutrient usage efficiency, decreased GHG emissions from fertilizer nutrient sources, and decreased fertilizer input costs.
- In India, there has been an earnest effort to spread awareness of Zero Budget Natural Farming (ZBNF). The phrase “Zero Budget” refers to all crops with zero production costs. The farmers’ revenue is increased as a result of ZBNF’s guidance towards sustainable farming methods that help to maintain soil fertility, assure chemical-free agriculture, and ensure a cheap cost of production. Compared to conventional agriculture, it offers a more environmentally benign and economically viable alternative and provides better climatic adaptation. To quote a real life example, in every one of the state’s ten agroclimatic zones, Karnataka has begun implementing the ZBNF on a pilot basis in an area of 2000 hectares through the relevant State Agriculture/Horticulture Universities. This helped improve soil quality within a single cropping season.
- The area covered by agroforestry is growing, resulting in increased carbon fixation and decreased GHG emissions. Along with providing environmental services, the inclusion of a price mechanism would help Indian agroforestry farmers maintain their standard of living. The area under agroforestry in India as well as in the rest of the world is a debatable issue. The number of trees vary from one (arid region of Rajasthan) to 200 per ha (Home gardens of Kerala) and there is no standard procedure to estimate them.
- The record milk production for the year was 176.3 mt in 2017–18, up from 132.4 mt in 2012–13. In addition to marketing and development of the agri-preneurship ecosystems in India, other livestock-related regulations contributed to animal health, immunization, the availability of fodder, and artificial insemination.

RECOMMENDATIONS/PATHWAYS FOR THE FUTURE

1. **OUTCOME MANAGEMENT:**
    - Encourage the use of sustainable soil management practices like controlling traffic, avoiding excessive tillage, managing pests and nutrients efficiently, selecting adequate crops and rotations etc. by offering incentives to farmers on their use, offer incentives for the adoption of renewable energy technology and make sure that the help reaches the genuine needy through DBTs, and encourage the Ministry of Agriculture to spend money on the research and development of new seed varieties to increase productivity.
    - Promote crop variety through introduction of new genes or diverse hybridisations, create a thorough risk management plan through the involvement of The Ministry of Agriculture and Farmers' Welfare (MoA&FW), and support agroforestry practices to build resilience, through practices like alley cropping, windbreaks, silvopasture, riparian buffer strips, forest farming etc.
    - Establish and carry out rules and standards for sustainable livestock management practices and promote decreased tillage practices through steps like using chisel plow shanks, subsoilers or zone-tillers to loosen soil instead of plows and harrows, mowing crop residues instead of disking, planting summer cover crops, such as buckwheat, after an early cash crop as a substitute for repeated harrowing to control weeds etc.

2. **REGIONAL MANAGEMENT:**
    - Use digitalization tools and technologies to efficiently differentiate CSA management across India's regions, collect real-time data and information on regional variations, provide farmers with specialized, region-specific extension services, make the best use of available resources, and promote stakeholder engagement and collaboration. Farmers are the primary custodians of knowledge about their environment. Adapting to CSA must be related to local farmers' knowledge, requirements and priorities.
    - Weather predictions, soil health checks, and crop advisories are just a few of the personalized, region-specific extension services that can be sent to farmers through digital platforms. For example, Esoko sends market information (prices for specific commodities, market locations, etc.) to agents and farmers, connecting them to commodity buyers, Arya, an online marketplace for farmers offers post-harvest service in the form of an online agriculture marketplace along with other services such as warehousing, financing, collateral management, and market linkages etc. As a result, farmers may be able to embrace techniques and technologies that are appropriate for their particular socioeconomic and agroecological circumstances.

- Digitalization can also support collaboration among stakeholders by bringing together farmers, decision-makers, researchers, and other stakeholders to share knowledge and best practices. This approach supports the development of relevant policies, plans, investments and coordination across processes and institutions responsible for agriculture, climate change, food security and land use. This can make it easier to create regionally specialized policies and initiatives that support CSA techniques and innovations.
- By customizing the taxonomies for each country's crop and region, the CSA ontology must be accepted globally as the foundation for all G20 nations. This can then be applied as a universal framework customized for local needs. Each nation can select its own course which will aid in formalizing and disseminating information on, feedback on, and lessons learned from implementation within a country to other G20 countries as well as non-G20 nations. It will contribute to the transition from a selective, segmented, and compartmentalized endeavor to a synoptic, systemic, and systematic cycle of knowledge generation and application on the topic.

3. **CROP MANAGEMENT:**
    - Differentiating CSA management strategies for different crops requires identifying the special agro-ecological and socioeconomic circumstances of each crop and developing policies and programmes that are appropriate to the region. Various crop management techniques like crop rotation control, irrigation management, crop type classification (on the basis of uses or life cycle for example) etc. can be used to differentiate and then club similar crops into defined categories to further ideate on the CSA techniques that can be brought upon them.
    - Encourage the adoption of integrated crop management techniques for crops having similar climatic requirements, soil health conditions, irrigation needs etc. to concentrate on maximizing resource utilization, lowering greenhouse gas emissions, and improving production across a variety of crops.
    - Implement precision crop management strategies to optimize resource utilization and boost productivity. These strategies make use of real-time data and information by utilizing digital tools like sensors, drones, and satellite images to track crop growth and health and give farmers immediate recommendations. Farmers can make data-driven decisions that are adapted to the regional climate by integrating meteorological data and information into precision agriculture systems.

4. **DIGITAL SEMIOTICS MANAGEMENT:**
    - There is an extensive network of weather stations in India that gather information on the country's temperature, precipitation, humidity, pressure, and wind patterns. The data may be processed using machine learning algorithms, which can then give farmers immediate information on weather forecasts, pest and disease outbreaks, and the best times to grow and harvest their crops.
    - In India, a wide variety of crops are grown in various places, each having its own specific needs in terms of temperature, precipitation, and other climatic conditions. It is possible to create crop-specific models utilizing data and climate information.
    - Farmers must be able to evaluate and use data and information on climate variability to their farming practices in order to utilize it effectively. To increase farmer proficiency in using digital tools and analyzing meteorological data, training programmes and extension services can be created. All farmers, particularly smallholder farmers, can have access to and afford these schemes if they are made that way.

CONCLUSION

A roadmap is needed for CSA's digital transformation. The difficulty of CSA must be addressed before the question of food security can be met, and digitalization is crucial to this endeavor. The G20 must lay out a plan for the global endeavor to realize the SDGs vision and set the course for the digitalization of CSA both within the G20 and worldwide.

The poor and marginal farmers who depend on agriculture for their livelihoods are most impacted by climate change. Climate change dangers can be reduced with the use of technology and wise practices. India is always working to develop and put into effect regulations that would improve the sustainability of its agricultural industry. The current trends in farming and agriculture have the potential to undergo a full transformation. Partnerships between corporations and the government can aid in the development of a smart agriculture industry given India's dynamic corporate structure.

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