Task Force 6
Accelerating SDGs: Exploring New Pathways to the 2030 Agenda

TOWARDS SMART AGRICULTURE: ADVANCING G20 COOPERATION IN AGRICULTURAL BIOTECHNOLOGY

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Abstract

The agriculture sector plays a crucial role in economic growth and inclusive development and is integral to food and nutrition security. Today, agriculture and allied sectors are facing numerous challenges, ranging from climate change, depleting natural resources, drought, extreme temperatures, and biotic stress. These challenges need to be addressed through active biotechnological interventions using critical and emerging technologies. The Agriculture Working Group of the G20 can coordinate at the policy level to address current challenges concerning agriculture. Genetic engineering and gene editing to improve the nutritional quality of crops and improve their resistance to pests and pathogens have potential to improve this sector within G20 countries. Additionally, translational projects like efficient nitrogen uptake and 'Realizing Increased Photosynthetic Efficiency' holds the promise of higher yields in a future where droughts could be more frequent and intense. Knowledge-sharing, technological collaboration, and technological innovations in these sectors, as well as capacity building in the scientific community and academia should be prioritised. These advanced agri-technologies supported by digitalisation can be seminal to improving resilience to climate change and producing biofortified foods to ensure food nutritional security, health, and sustainable development towards realising Sustainable Development Goal 2. This Policy Brief discusses these issues and offers scientific and policy recommendations.

The Challenge

1

Agriculture and allied sectors hold huge significance in the Indian subcontinent, particularly in the contexts of food, nutritional security, livelihoods, and economy.[1] Sustainable growth in these sectors is critical not only for the country's long-term and inclusive economic growth but also social empowerment. Globally, sustainable and inclusive agricultural development is critical to achieving development goals and feeding a population projected to reach 9.7 billion by 2050.[2] The agriculture sector has undergone considerable development through the efforts of public and private sectors across the world. Continuous growth in food grains, cereals, pulses, and oilseeds have provided for the nutritional requirements of the increasing population.

In the last two decades, advancements in genetics, biotechnology, and genetic engineering have proven to be 'game changers' in increasing the productivity of cereal crops (viz., rice, cotton, wheat, maize, sugarcane, and pulses), thereby addressing the issue of food security to a significant extent.[3] Since then, initiatives have focused on nutritional security and 'biofortification' to produce improved food crops with higher nutritional value.[4]

Research institutions in India, such as the Indian Council of Agricultural Research (ICAR), and the government, recognising the pressing need for nutritional biofortification, have initiated programmes in staple crops to address the challenge of malnutrition. Golden rice harbouring genes for enhanced ß-carotene content, and a precursor of Vitamin A have helped combat Vitamin A deficiency in children from sub-Saharan Africa and South Asian countries.[5] Biofortified crops generated by breeding, agronomy, and transgenic approaches are providing adequate levels of micronutrients to specific populations around the world.[6] Over the years, there has been significant progress in developing biofortified varieties of cereals, oilseeds, pulses, vegetables, and fruits.[7]

However, the agriculture sector at the global level is facing multiple challenges such as climate change, depleting water resources, and crop losses due to pests and pathogens, which can cause losses to food production, agriculture growth, and welfare of

farmers. India alone faces massive losses (~30 percent) to crop pests, including insects, rodents, nematodes, fungal pathogens, bacteria, and viruses.[8] Comparatively, India still has the lowest yield of prominent oilseed crops, namely, groundnut, soybean, and mustard, leading to a huge edible oil deficit. Pests and pathogens pose constraints to the yield of prominent crops.

The Food and Agriculture Organization (FAO) estimates annual losses up to 40 percent in global crop production to pests and pathogens, accounting for almost US$220 billion of the global economy.[9] Abiotic stresses like drought, waterlogging, extreme temperatures, salinity, and mineral toxicity have negative impacts on the growth, quality, and yield of crops.[10] These losses are bound to escalate with the risks posed by climate change.[11,12] Changes in temperature and water availability can make plants more susceptible to diseases. Climate change will increase the risk of pests in agricultural and forestry ecosystems, especially in the Arctic, as well as temperate and subtropical regions.[13]

Thus, the interconnected challenges of climate challenge, biodiversity loss, and environmental degradation are at a global level and need to be addressed by strengthening intergovernmental panels.

Challenges in the agriculture sector, including food and nutritional security and sustainable growth, have been part of G20 deliberations. The meeting of the Agriculture Deputies of G20 countries in Indonesia in 2022 identified a four-point agenda to address global challenges based on evolving global and regional trends in the agriculture sector. These include food and nutrition security, crop productivity, and gaps in the global value chain and employment.[14] The G20 member nations as well as other countries and communities across the world face these challenges, and therefore, immediate and sustainable actions are required from the international community, including the G20.[15,16]

The G20's Role

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The G20, comprising both developed and emerging economies, can help shape the path for economic resilience, global economic growth, and inclusive and sustainable development. Accelerating progress on the SDGs is a key priority of India's G20 Presidency, which is set to hold six meetings on scientific cooperation under the Research and Innovation Initiative Gathering (RIIG).[17] RIIG aims to serve as a platform to share ideas, create partnerships, and focus on different aspects of technological progress and challenges. The target of SDG-2 is to create a hunger-free world by 2030 through doubling agricultural productivity and the income of farmers, ensuring sustainable food production systems, and implementing resilient agricultural practices that will strengthen the adaptive capability to climate change, weather extremities, drought, and biotic stresses, as well as improve land and soil quality.[18]

Agriculture and food security amidst climate change appeared on the G20 agenda for the first time during the Pittsburgh Summit in 2009. Consequently, the Global Agriculture and Food Security Programme (GAFSP) was established in 2010 to support resilient and sustainable agriculture and food systems in low-income countries.[19] The Agriculture Working Group (AWG), since its inception in 2011 at the Cannes Summit in France during the sixth meeting of the G20, has been focusing on the steps required to address agriculture and food challenges.

In 2014, the G20 countries adopted the Food Security and Nutrition (FSN) framework, prioritising the objectives of promoting infrastructure investments, overcoming agricultural market failure in developing countries, and promoting international collaborations in research, development, and innovation, catering to the needs of developing countries. The G20 Declaration in November 2022 also emphasised scientific cooperation for agricultural growth and development and welcomed global, regional, and national initiatives in support of food and nutritional security.[20] The focus agendas of the summit include developing an action plan to strengthen dialogue between producers and consumers, increasing investment in food and energy security needs, and ensuring resilient and sustainable agriculture as well as energy systems.[21] The G20 members have achieved a consensus on adopting alternate

grains and traditional crops in the respective countries to support food security and nutrition requirements. For example, 2023 is being celebrated as the International Year of Millets across the globe, upon the initiative of India.[22] Millets are good for consumers as they provide most of the essential nutrients, as well as being good for cultivators and the climate, since they are extremely resilient to drought and other harsh weather.[23]

The deliberations at the G20 summit of member nations at Chandigarh in March 2023, under India's presidency, agreed on four focus areas: food security and nutrition, climate-smart agriculture, inclusive agriculture value chains, and digitalisation for agricultural transformation.

Augmenting G20 Agri-Biotech Cooperation: Key Sectors

There are multiple emerging areas in which the G20 countries can cooperate and share their knowledge and technological know-how and jointly work towards technological and scientific innovations and solutions.

First, genetic engineering and gene editing are two important technologies to be focused upon to bring new avenues for crop productivity and crop resilience to change climatic conditions. For example, the cultivation of pest-resistant transgenic BT cotton, Vitamin A-enriched Golden Rice, and Pro-Vitamin A-enriched transgenic bananas have brought significant quality enhancements in crop products and enhanced the sustainability of small landholders in both developed and low-income nations.[24] Second-generation advanced gene editing technologies like CRISPR/Cas9, which allow precise mutagenesis locally, are being used to edit model plant genomes as well as crop species for yield improvement as well as biotic and abiotic stress management.[25] The availability of high throughput genomics and functional data, as well as the emergence of advanced technologies of gene editing, are enabling researchers to address various challenges in agriculture and allied sectors. These technology advancements have made new approaches possible, including disease resistance, supercharged photosynthesis, shorter and stronger stalks, expanded roots, and improved tolerance to elevated salt concentrations.[26] Such crop varieties

can make agriculture climate-resilient as well as ensure sustainability under changing climatic conditions.

Second, improved technologies to increase 'nitrogen use efficiency' (NUE) are needed to increase the productivity of global food systems and improve the quality of air, soil, and fresh waters.[27] Three key options have been identified jointly by the Biotechnological and Biological Sciences Research Council (BBSRC, UK), the Department of Biotechnology (DBT, India), and the Natural Environment Research Council (NERC, UK) to support better nitrogen management in agriculture: a) enhancing the nitrogen-fixation in legumes and tapping the potential of biological nitrogen fixation to non-leguminous cropping systems; b) improvement of NUE at plant level; and c) improvement of NUE through agronomic practices.[28] Nitrogen management in smallholder farming systems lies at the core of several SDGs—from ending hunger to resilience to climate change.[29] Improved nitrogen management, accompanied by policy reforms and investments, could be key in precision agriculture. Crop protection and improved yields of crops like soybean and chickpea can help meet the protein requirements of malnourished populations in developing countries as well as benefit non-member countries. Therefore, it would help to establish joint centres that can link leading legume and NUE research communities of the G20 countries.

Third, Realizing Increased Photosynthetic Efficiency (RIPE) is another key area of focus. RIPE aims to harness the power of the Sun to improve plant photosynthesis, leading to increased crop production.[30] Achievements in this project include: a) genetic manipulation of crop plants using algal protein to improve photosynthesis and growth while using less water;[31] and b) achieving ultra photosynthesis by targeting the respiration protein RuBisCO to increase crop biomass up to 40 percent.[32] These new advances point to higher-yielding crops that are tolerant to higher temperatures and increased carbon dioxide levels in a drought-afflicted future.[33] Also, research and experimental development (R&D)-based solutions are required to create adaptation to waterlogging in crop plants.[34] These thrust areas of active biotechnological intervention seek strong policy support and coordination. Efforts need to be made to further boost research to develop climate-resilient crop varieties.

Fourth, development of agricultural value chains also needs to be an area of focus. The disruption of the value chain can have a direct impact on the income of small farmers. Dynamic pathways connecting local food systems to growing urban markets need to be worked out. The G20 nations are shifting from a production-centric approach to a value-chain one, which must be more inclusive, resilient, and sustainable. Strong commitment of governance, infrastructure, and policies is required to promote the growth of agriculture value chains within and between countries. Digitalisation of the agriculture sector has emerged as an additional focus area within the G20 countries to achieve the SDGs.[35]

Digital interventions in the format of 'Agri-Stack', which can link existing digital land records, geospatial maps of farms, crop data farm-wise, and soil profile can supplement human resources towards realising 'smart and well-organised agriculture'. Such digital programmes and efforts can help streamline the available information to farmers regarding seeds, fertilisers, logistic facilities, plant health and weather advisories, irrigation facilities, market access information, and farm equipment, and make it universally accessible. A centralised farmers database would enable the use of artificial intelligence, which can eventually help in managing farms more effectively. Recommendations pertaining to seeds, suitability of soil profiles to crops, and dissemination of best practices will maximise crop yield, increase farmers' income, and improve the overall efficiency of agriculture and allied sectors.

The role of information and communication technologies has been at the forefront of the G20 agriculture ministers meet. The launch of the G20 Agricultural Market Information System (AMIS) was one such tangible step taken to address food price volatility. The G20 can help craft a well-defined and actionable roadmap through policy framework to harness the potential of these biotechnologies through bilateral and multilateral cooperation.

Recommendations to the G20

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- The G20 should facilitate global cooperation by providing a platform for countries to engage in constructive dialogue and coordinate their efforts towards addressing global challenges. Accounting for over 80 percent of global gross domestic product (GDP), the G20 countries have significant influence on policy discourse. Developed nations have successfully transformed agriculture through advanced technologies, R&D investment, rural infrastructure, and strong policies, highlighting the importance of international cooperation in addressing the challenges as well as facilitating the march towards smart agriculture and achieving SDG-2.

- The G20 should prioritise technological cooperation to enhance agricultural productivity in developing and low-income countries. India's foreign policy has emphasised cooperation in agriculture with partners within continental and regional bodies such as the African Union (AU), the Association of Southeast Asian Nations (ASEAN), and the Shanghai Cooperation Organisation (SCO). Greater diplomatic efforts are also needed at the G20 level to energise science diplomacy for establishing a robust system for research cooperation.

- To deepen research collaboration in agricultural biotechnology, the G20 should establish a practical model through science and technology cooperation between its members, drawing on successful initiatives between India and Australia, such as the AISRF and technology transfer collaborations. These engagements have significantly impacted farmers, economies, and the environment in both countries. Similar successful examples can be drawn from European countries. The G20 should establish a specific institutional setup or initiatives to regularly exchange expertise and technology among members.

- The G20 should promote open sharing of science and technology to ensure accessibility and international collaboration, focusing on problem-solving and capacity-building at the human resource level through R&D funding. A joint fund for agricultural biotechnology

research should be created. To promote translational research projects like NUE and RIPE, the G20 should initiate fellowships and student exchange programmes similar to recent initiatives from minilateral formats like the Quad (United States, Japan, India, and Australia).

- To promote joint research projects among the G20 countries, efforts should be made to enhance research capacity and infrastructure of state and private universities and research institutions. Private universities are expanding their role and outreach, which will widen the G20 research network and expand outreach at the community level. Bringing them into mainstream science diplomacy and international cooperation will contribute to the overall growth of research and innovations.

- The G20 members have a tradition of promoting scientific research and nurturing academic networks, with several examples of successful research programmes. The G20 should adopt a similar approach and encourage young researchers and scientists to participate in agri-biotech research within this network.

- Promoting affordable solutions with a focus on marginalised communities should be emphasised. The transition of technology from research institutions to the actual field should be explored and systematically planned. In an increasingly interconnected world, it would also be pertinent to augment the global role of the G20 in argi-biotechnology research, as the G20 research community has the potential to provide scientific solutions to countries that are not members of the G20.

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