Role of STI in Sustainable Development: Towards Food and Nutrition Security

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Introduction

Even after decades of self-sufficiency in food production, India still has a high rate of hunger and malnutrition. India ranked 101st out of 116 countries in the Global Hunger Index (GHI) 2021. According to the report, 15.3 percent of India's population is undernourished, and 34.7 percent of children under the age of five are stunted, indicating a high prevalence of hunger and chronic under nutrition. The situation is expected to worsen further as a result of climate change and its consequences. Extreme climatic variations and predicted temperature changes are likely to have an impact on crop yield and pest population. In this context, achieving 'zero hunger' by 2030 is a massive challenge that necessitates the convergence of Science, Technology, and Innovation (STI) and various forms of knowledge with policy.

This article examines India's STI policy landscape in terms of nutrition and food security, and attempts to understand the importance of STI in achieving the "Sustainable Development Goal" (SDG) 2\(^1\) SDG 2 focuses on achieving food security and enhanced nutrition, as well as promoting sustainable agriculture\(^2\). The article discusses the policy landscape in agriculture and nutrition, as well as the problems and issues in leveraging technologies for social good. It also highlights some of the STI practices in both developed and developing countries, for food and nutritional security.

Global Landscape

Global interventions to curb hunger and malnutrition began in 1974, when the World Food Conference introduced the concept of "food security" (Shaw, 2007). However, food security at the time was limited to maintaining basic food stock prices on a national and international scale. Later, in 1983, the "Food and Agricultural Organization" (FAO) stressed the importance of equal food availability, shifting the concept of food security to the individual level. Following that, the concept of food security advanced significantly with the official declaration of the World Food Security concept in the 1996 - Rome Declaration (Maxwell & Smith, 1992). Since then, agencies such as the UN, FAO, World Bank, OECD, and IFPRI/CGIAR, to name a few, has formulated various policies and strategies to solve the problem of rising hunger and malnutrition. Several policies and frameworks were developed* to establish access to food as a ‘human right’ and delineate all international laws that pertain to food security, nutrition, and human rights.

In one or many ways, these policies have acknowledged the importance of STI in improving global food security. For instance, the Rome Declaration on the World Food Security in its plan of action has particularly emphasized developing and promoting labour-intensive and sustainable technologies and improving food processing, preservation and storage technologies at the local level to reduce post-harvest food losses. Similarly, the Declaration of the World Summit on Food Security, 2009 stressed on increasing agricultural productivity to match increasing food demand through review, approval, and adoption of biotechnologies and other new safe, effective, and environmentally friendly technologies. However, the recent UN Food

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\(^1\) Sustainable Development Goal 2 (SDG 2) for detail https://in.one.un.org/page/sustainable-development-goals/zero-hunger-programme-sdg-2/

\(^2\) See for detail https://www.un.org/sustainabledevelopment/hunger/

*The policies and programmes developed were, the World Food Summit Plan of Action, the Rome Declaration on World Food Security, the Final Declaration of the 2009 World Summit on Food Security, the Millennium Development Goals (MDGs), the Voluntary Guidelines to Support the Progressive Realisation of the Right to Adequate Food in the Context of National Food Security (VGRFT), the Five Rome Principles for Sustainable Global Food Security – 2009, the Voluntary Guidelines on The Responsible Governance of Tenure Of Land, Fisheries and Forests in the Context Of National Food Security (VGGT), Sustainable Development Goals (SDGs), and United Nations Updated Comprehensive Framework for Action (UCFA)
System Summit 2021, on the other hand, recognised the importance of inclusivity and innovation in food system governance and action.

Despite these guidelines, the global prevalence of hunger and malnutrition continues to climb. According to the State of Food Security and Nutrition in the World 2021, between 720 and 811 million people globally were affected by hunger. Africa was at the top of the list, with 21 percent of the population battling hunger, followed by Latin America and the Caribbean (9.1 percent each) and Asia (9.0 percent). Global undernourishment continues to be a serious problem. In 2020, out of total undernourished people (768 million), more than 50 percent (418 million) were Asians, more than 25 percent (282 million) were Africans, and 8 percent (60 million) were Latin Americans and Caribbeans.

Indian Scenario

Over the last 70 years, India has adopted a range of measures to address the problem of food security. The establishment of the publicly funded 'Public Distribution System' (PDS) is India's first concerted response to the problem of food insecurity and hunger. The PDS system's main purpose was to ensure that everyone had access to food. However, in India, the concept of food security achieved formal status only when the Indian government ratified the National Food Security Act (NFSA) in 2013. All Indian citizens have the right to food security under the National Food Security Act. It was put in place with the goal of bolstering PDS through statutory support. In terms of policy, providing a uniform ration to the entire country is a noteworthy success; yet, the program's impact on improving the nutritional state of the mass is still being debated. This homogeneous cereal supply does not seem to have eased India's nutrition problem (FAO, 2020). Ranked among the worst in the GHI, the national priority to address nutrition is evident in several Union government policies and in several state nutrition programmes. Science and Technology (S&T) have been a vital component in all these policies.

S&T policies and programmes for agriculture and food security in India

If we delve into history, we will find that science and technology have immensely aided Indian agriculture, as evident in the Green Revolution, Blue Revolution, White Revolution and Golden Revolution. The Government of India has developed many technology-driven flagship projects, such as the National Food Security Mission³, National Mission Oil Seeds⁴, National Mission for Integrated Development of Horticulture³, and so on, to reduce yield gaps and improve technology adoption.

To increase the production and productivity of food grains, the Green Revolution was initiated by the government, which led to the introduction of High Yielding Varieties (HYVs) of seeds in India. The Green revolution played an instrumental role in achieving self-reliance in food grains. It significantly boosted the production of wheat and rice crops, and improved the overall status of food security in the country. Since the initiation of the Green Revolution, various breeding and molecular breeding programs have been implemented by the government to accelerate the adoption of agricultural biotechnologies in India. To boost mechanisation in agriculture, the government has launched several programs through multiple sub-missions such as Rashtriya Krishi Vikash Yojana

[3] For detail please refer to www.nfsm.gov.in
[4] For detail please refer to www.nmoop.gov.in
[5] For detail please refer to www.midth.gov.in
(RKVY), National Food Security Mission (NFSM), National Health Mission (NHM) and National Mission on Oilseeds and Oil Palm (NMOOP). Initiated in 2007, RKVY is an umbrella scheme for achieving holistic development of agriculture and allied sectors. Adopted in 2007, NFSM aims “to increase the annual production of rice by 10 million tonnes, wheat by 8 million tonnes and pulses by 2 million tonnes by the end of the Eleventh Plan (2011-12)”. Launched in 2013 by subsuming the ‘National Rural Health Mission’ and the ‘National Urban Health Mission’, NHM’s primary objective was to address health and nutrition needs of people. Introduced in 2014-15, NMOOP scheme aims to increase the oilseeds production in the country. With reference to STI, NMOOP guidelines emphasize on distribution of technologies developed by ICAR’s/SAUs/KVKs and other R&D organisations for achieving higher productivity in oilseed cultivation. Furthermore, it also assures supply of improved farm implements like rotavator, seed drill, crop-planter as per rate of submission on agricultural mechanization. Furthermore, water being an essential input for agricultural production and its significant role in sustainable food security, the union government has launched ‘Pradhan Mantri Sinchayee Yojana’ (PMKSY) for sustainable use of water. PMKSY focuses on creating assured and protective irrigation sources by harnessing rainwater at the micro-level through ‘Jal Sanchay’ and ‘Jal Sinchan’. One of the primary objectives of PMKSY is the adoption and promotion of precision irrigation and other water-saving technologies, mainly through micro-irrigation techniques such as drip and sprinkle. In 2020-21, 9.38 Lakh Ha (drip - 3.57 Lakh Ha, sprinkle - 5.81 Lakh Ha) land were irrigated through micro-irrigation techniques.

Similar to PMKSY, many other science and technology-based programs such as Integrated Nutrient Management (INM), The Paramparagat Krishi Vikas Yojana, National Programme for Organic Production, Agricultural Technology Management Agency (ATMA), particularly in the area of nutrient management, organic farming and information technology has been formulated in the country.

The agricultural policies over the years have focused on increasing yield and promoted staple crop production (particularly rice and wheat) with several input subsidies. But the incidences of hunger and malnutrition in the country have been high. Increased production of staples or increased income due to that might not lead to food security. There are several factors such as access to nutritious and diverse food, culture and dietary habits, market prices, disposable income, etc which influence food and nutrition security. Over the years, increased focus on staple crop production has discouraged the production of traditional non-staple crops like pulses, millets and legumes (Raina, 2014). This led to the reduction in complex, dynamically evolving biodiversity to mere species counts of plants, introducing new culinary preferences by supplying major staples at subsidised rates across spaces, people and practices. This poses danger not only from the perspective of dietary diversity and its nutritional contents but also for sustainable food production. Loss of plant species diversity has far reaching impacts on dietary diversity and nutrition intake of individuals. Globally, about 75 percent of plant genetic diversity has been lost as genetically uniform, high-yielding varieties have gained prominence. In today’s world, about 75 percent of the food consumed is derived from only 12 species of plants and 5 species of animal, and of the 250,000 - 300,000 edible plant species known worldwide, only 150-200 species are used by humans (FAO, 2004). It has been found that...
people relying on homogenous diets or processed items, either lack minimum minerals and vitamins, or contain high amounts of fat, salt and sugar (FAO, 2020). Several reports have highlighted that the declining diversity of food systems poses threat to adequate nutrition and farming communities’ capacity to adapt to climate variability and change (FAO, 2019). According to the International Union for Conservation of Nature (IUCN) Red List of Threatened Species, 2021, about 20 percent of wild species which serve as human food are threatened.

Since climate change is now a reality and is expected to have a detrimental effect in all production areas, including agriculture, the Union Government has launched the ‘National Mission for Sustainable Agriculture’ (NMSA), under the ‘National Action Plan on Climate Change’ (NAPCC). NMSA relies on ‘Water use efficiency’, ‘Nutrient Management’ and ‘Livelihood diversification’ through adopting a sustainable development trajectory and shifting to green technologies. Moreover, a network project viz. ‘National Innovations in Climate Resilient Agriculture’ (NICRA), 2011, focuses on resilient Indian agriculture through strategic research and technology demonstration. Since its inception, NICRA has contributed significantly towards adaptation of Indian agriculture. Under this project climate-resilient technologies and climate-smart crop varieties/cultivars of rice, wheat, maize, pigeon pea, black gram, green gram, tomato, onion tolerant to abiotic stresses have been developed. Under NICRA, 150 climate-resilient villages have been established by custom hiring farm machinery, demonstrations of technologies in 6803 farmers’ fields covering 3431 ha., organising 722 training programs, and identifying 27 climate-resilient practices for up-scaling under NMSA (Rao, n.d.).

Programmes and policies for nutrition in India

The prevalence of vitamin A deficiency and anemia in India is high and significantly higher among agricultural households and households belonging to ST and SC communities (NNMB, 2003). According to the ‘Comprehensive National Nutrition Survey’ 2016–2018, in India among children aged 0–4 years, 35 percent were stunted, 17 percent were wasted and 33 percent were underweight. The survey also found the prevalence of anemia to be highest among pre-schoolers aged 1-4 years (41 percent), followed by children aged 5–9 years (24 percent), adolescents aged 10–19 years (28 percent) (MoHFW, 2019). An estimated two thirds of deaths among children under five are attributed to under nutrition (Swaminathan et al., 2019). The root of these crises lies in the dysfunctional framework between agricultural and dietary patterns which fails to meet nutritional requirements of everyone (De Clerck et al., 2011). India adopted a national policy on nutrition - National Nutrition Policy in the year 1993, which viewed under-nutrition as a complex development problem linked to agriculture, food production, and poverty and needs to be tackled at various levels. Further, in 1995, a National Plan of Action on Nutrition was launched to operationalise the multi-sectoral synergy envisaged in the policy. There are several programmes of the Union Government that targeted the underprivileged’s health and nutrition, such as Integrated Child Development Scheme (ICDS); policies for control of nutritional anemia among mothers and children; elimination of Vitamin A deficiency through Vitamin A supplementation, etc. A 'Special Nutrition Programme' was launched in 1971 targeting the tribal areas and the slums to improve their nutrition status. The 'Wheat Based Supplementary Nutrition Programme' was launched in 1986 to popularise wheat consumption by increasing
the utilisation of wheat-based products in the supplementary nutrition provided under ICDS. In all these programmes food fortification, complementary nutrition, Vitamin A, Iron and folic acid supplements, wheat based ready to eat nutrition supplements etc. have been the major components to address the nutritional crises but the core problem of the linkage between agriculture and nutrition has not been explicit. Also, flagship programmes like ‘Mid-Day Meal scheme’ (to provide 300 calories and 8-12 grams of protein to all children studying in classes I – V in Government and aided schools), ‘National Nutrition Mission’ (to improve nutritional outcomes for children, pregnant women and lactating mothers in a mission mode) etc. have steered to mitigate the hunger and malnutrition problem. However, such policies do not address the food and dietary patterns which influence consumption. Neither does these policies include farmers, their choice of crops to be grown, geographic location, cultural aspects of nutritional habits, post-production issues or other social factors needed to address the root cause of malnutrition and under-nutrition.

Best Practices

Different knowledge systems and innovation in India as well as in other countries exists which have led to nutritional and food security. In India, we witness many production systems in different agro-ecologies like mountainous, coastal, rain-fed and arid systems, which have gained little from the Green Revolution. Several communities in these agro-ecological regions practice traditional food production systems, which are suited to the geography and the climatic conditions characterised by low inputs, ecologically integrated, and most importantly driven by skills and knowledge of the people. For example, the Baranaja cropping system of Uttarakhand which consists of twelve or more different grains like finger millet, horse gram, black gram, soyabean, cowpea, pigeon pea, pulses, amaranth, buckwheat, etc have been traditionally grown to meet nutritional requirements. The traditional food system among the tribals in the Medak district of Telangana have been exemplary in improving nutrition among the community. Their food system includes an extensive variety (329 species/varieties, many unrecognised till date) of cereals, millets, pulses, oil seeds, fruits, vegetables, greens, roots and tuber, which have survived over the years mainly due to conservation of rich agro-biodiversity and continuation of traditional practices. The Bhil community in Madhya Pradesh are known to grow around 95 local species which provide around 59 percent of their daily energy requirements (FAO, 2009).

There are also several examples of developing countries where conventional breeding techniques have been used for biofortification or to improve the nutritional status. For example, in Kenya, conventional breeding techniques have been used to create ‘yellow cassava,’ which is highly rich in provitamin and trials conducted on children have shown that conventionally bred biofortified cassava was effective in addressing vitamin A deficiency (Talsma, et al., 2016). Intercropping of maize/millet with legumes (pigeon peas, ground nuts) for better nutrition with inclusion of proteins and vitamin A has been used in Malawi (81). This resulted in higher grain yield than sole cropping through farmers-to-farmers extension in Mzimba district, with 17 to 49 percent increase in productivity. Farmers feeding improved Brachiaria grass to their dairy animals have recorded an increase in milk production by 15 to 40 percent in Kenya, (87) and Tanzania (92). A high variation is found in the biomass productivity among the Brachiaria cultivars in Kirinyaga and
Kangundo, Kenya. Sorghum-legume intercropping with conservation agriculture practices shows greater biomass yield (≥6.4 t/ha) than conventional practice (5.3 t/ha) in Tanzania.

Conclusion and Way Forward

In India, increased production of food grains did help in raising farmers’ income. However, since the Green Revolution, most of the traditional agricultural food production system, local dietary traditions, and the use of science and technology for nutrition security have been underutilised due to an overwhelming reliance on a few main crop productions. Depending on the agro-ecological system, there exists variability in farming practices, food production, and consumption patterns in India and other developing countries. In such system nutrition is linked to the local agro-ecological system and the local biodiversity within the system, both of which are formed by age-old community knowledge and culture. In the Indian context, to achieve food and nutritional security and attain SDG 2 agenda, there is a need to incorporate such local and traditional practices into the agricultural and food system. Moreover, there is a need to acknowledge the interconnections between food, water and agriculture to meet the human needs in a resilient, just and equitable manner. There is a need for scientists, farmers/agricultural producers and other stakeholders to work together to acknowledge and incorporate the different ‘agricultural practices based on local knowledge’ for a sustainable food production system. Since India’s forthcoming STI policy which emphasises on development of sustainable and indigenous technologies in agriculture, the mainstreaming of traditional knowledge and practices will be critical in building a robust sectoral innovation system, driven by collaborative efforts and partnerships.

References


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