Agricultural Powerhouse in the World

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In the agriculture and food sector, our country has achieved sustainable food security due to its large population and has also earned the coveted title of the world's agricultural powerhouse. Beyond self-sufficiency, India is now a major exporter of agricultural products with a large share of rice, cotton, soybeans and meat exports. During her unprecedented Covid-19 pandemic, India has emerged as a global supplier of food and other agricultural products.

India is efficiently feeding and managing nearly 18% of the world population with only 2.4% and 4% of global land and water resources respectively. Consistent agricultural and land reforms, progressive and inclusive policies, and application of Science and Technology' at the ground level pushed-up productivity, production, and quality of agricultural products at a remarkable pace. Consequently, India is now the largest producer of pulses, jute, and milk, and ranks as the second-largest producer of rice, wheat, sugarcane, cotton, and groundnuts in the world. It also holds the second position in global fruit and vegetable production with a high rank in the production of mango, banana, papaya, and lemon.

With many feathers in its cap, the agriculture sector is now a proud entity with global acclaim, but the situation at the time of independence was quite deplorable. In addition to recurrent famines, the country lost major wheat and rice growing areas to Pakistan due to partition. In 1950-51, India produced around 50 million tonnes of food grains, which was not enough to feed the population of 350 million. To save its growing population from hunger, India resorted to the import of food grains which ultimately led to ‘ship to mouth’ living. Meanwhile, Indian leadership realising the critical importance of agriculture in the National Food Security Act (NFSA), proclaimed 'everything can wait, but not agriculture'. Hence, a slew of measures was initiated mainly to improve and extend irrigation facilities and bring in a 'scientific temper' in agriculture and allied sectors. Strengthening of the nationwide agricultural R&D network was fast-tracked, along with the creation of agricultural education facilities and extension services to farmers. However, in our land of traditional agriculture, it was first recognised as a 'subject of scientific improvement' in 1871 when British rulers established a 'Department of Revenue and Agriculture and Commerce'. Although the Department had a mandate for agricultural development, it mainly focused on revenue. In

fact, British rulers did not intend to feed the famine-afflicted India, rather desired to direct agriculture towards the production of raw materials for British industries, especially for the textile industries of Manchester. However, some research institutions were established at a very slow pace, which later emerged as the light-house of agricultural development in independent India. The Imperial Bacteriological Laboratory (1889) was the earliest institution established in Pune, which later evolved as the prestigious ICAR-Indian Veterinary Research Institute with headquarter at Izatnagar, Bareilly, UP. Similarly, the Imperial Agricultural Research Institute established in 1905 in Pusa, Samastipur, later became the distinguished ICAR-Indian Agricultural Research Institute (IARI) at New Delhi; and the Imperial Institute of Animal Husbandry and Dairying established in 1923 in Bangalore, later grew to become the eminent National Dairy Research Institute in Karnal, Haryana.

The Royal Commission on Agriculture, appointed in 1926, recommended the setting up of an Imperial Council of Agricultural Research to endorse, direct, and organise agricultural veterinary research across the country. Thus, a central research coordination agency came up in 1929 which later evolved and was renamed the Indian Council of Agricultural Research (ICAR), soon after independence. Meanwhile, basic research continued at the provincial level under the respective departments of Agriculture and Animal Husbandry through the agricultural and veterinary colleges. Notable institutions under the provinces were the Sugarcane Breeding Station founded in 1912 in Coimbatore (which later became ICAR-Sugarcane Breeding Institute); and the Rice Research Station established in 1911. On the other hand, the Central Ministry of Food and Agriculture emphasised on commercial crops, and constituted semi-autonomous bodies or commodity committees to conduct research, specifically for improving the quality of the products. The first such committee of cotton was established in 1921, which led to the development of 70 improved varieties and considerably improved fibre quality. Subsequently, these committees were established for the overall improvement of lac, jute, sugarcane, coconut, tobacco, oilseeds, areca nut, cashew nut, and spices.

They established their own specific research institutions to conduct advanced research, such as Cotton Technology Research laboratory at Bombay; Indian Lac Research Institute at Ranchi; Jute Agricultural Research Laboratory at Dhaka (later relocated to Calcutta in 1947); Central Research Station at Kayankulam and Kasargod; Indian Institute of Sugarcane Research at Lucknow; and the Central Tobacco Research Institute at Rajahmundry.

On the agricultural education front, the first Agricultural School was opened at Saidapet, Chennai in 1868, which was later relocated to Coimbatore in 1906. Likewise, the Department

for teaching agriculture in the College of Science at Pune (founded in 1989) was later developed into a separate college of agriculture in 1907. A series of agricultural colleges were established at Kanpur, Sabour, Nagpur, and Lyallpur (now in Pakistan) from 1901 to 1905. These colleges were mainly devoted to teaching, but research activities could not be carried out due to the lack of scientific and technical manpower and facilities.

Towards Self-Reliance

After independence, Indian policy planners accorded top priority to agricultural development with the ultimate goal to make the country self-reliant in staple foodgrains, i.e., wheat and rice. Accordingly, several specific initiatives were taken in the first Five Year Plan to uplift agricultural growth along several verticals. Major irrigation projects were launched and land titles were given to actual cultivators under land reforms. Co-operative credit institutions got a boost due to better financing and an initiative was taken up to bring institutional changes in the agriculture support system. Consequently, India harvested nearly 70 million tonnes of foodgrains (wheat, rice, coarse cereals, and pulses) during 1956-57, but due to the growing population, it could not lessen the country's reliance on imports. In the Second Five Year Plan, agriculture was shifted downwards in the priority list to accommodate industrial development for boosting the economy. During the 1960s, India continued with the escalation of imports, mainly from the USA under the PL-480 scheme. In and around 1965, the country suffered three major setbacks on the food front- severe drought, war with Pakistan, and imposition of strict curbs by the USA on delivery of wheat. India somehow managed to avoid the severe trap of famine and hunger by importing an all-time high, 10 million tonnes of foodgrains in 1966 from various sources. In the Third Five Year Plan, the Government made a strong commitment to making the country self-reliant in foodgrains production, mainly through scientific and technological interventions, and implementation of conductive policies at farm-level. The Government of India permitted trials of Mexican wheat varieties in fields.

These varieties, developed by renowned American Agronomist, Dr Norman E Borlaug (1914 to 2019), were dwarf/semi-dwarf, rust-resistant, and had already shown potential to enhance yield manifold. Over 1,000 trials/ demonstrations were conducted in farmers' fields across the north Indian wheat belt under the mentorship of eminent Plant Geneticist Dr M S Swaminathan. Farmers successfully harvested 4-5 tonnes per hectare yield in contrast to earlier one tonne hectare with Indian varieties. This was a quantum jump never imagined earlier. The clamour for new high-yielding seeds grew rapidly across wheat-growing areas due to the excellent performance of new wheat varieties and personal motivation to farmers by the great duo- Dr Borlaug and Dr Swaminathan. Agriculture departments and R&D institutions facilitated a regular supply of quality seeds, fertilisers, machinery, irrigation facilities, and more importantly, scientific advisories. In 1968, our nation reaped a bumper harvest of nearly 17 million tonnes of wheat that was just 11 million tonnes in 1966. This was the biggest leap of wheat production ever recorded globally. This spectacular achievement was recognised as 'Green Revolution' over the world.

Acting almost on a similar pattern, the Government of India indented seeds of dwarf and high-yielding rice variety IR-8, developed by the International Rice Research Institute at Manila, Philippines. Its seeds were distributed among farmers, mainly in the southern and eastern regions. In comparison to merely 2 tonnes per hectare yield from local varieties, farmers could reap a bumper harvest of 6-7 tonnes per hectare, and that too in a short duration of only 105 days. Farmers adopted this variety widely, and Indian rice breeders developed a series of 'IR' varieties with a yield potential up to 10 tonnes per hectare. Thus, an era of high-yielding varieties of crops began with new dimensions such as multiple cropping, a package of good agricultural practices, an extension of modern farm practices and irrigation facilities, and a newer approach towards post-harvest technologies. During the post-Green Revolution period, policy planners focussed more on research, extension, education, input supply, credit support, marketing, price support, and institution building. The new strategy has enabled the country to increase the production of foodgrains by 5.6 times, horticultural crops by 10.5 times, fish by 16.8 times, milk by 10.4 times, and eggs by 52.9 times from 1950-51 to 2017-18. As per fourth advance estimates, for 2020-21, total foodgrain production in the country is estimated at a record 308.65 million tonnes. Horticulture production is expected to reach a record level of 329.86 million tonnes in 2020-21 (2nd advance estimates). Thus, India has travelled a long journey from being a famine-afflicted and food-scarce nation to a proud food- surplus nation.

Building Networks

During the 1950s and 1960s, the Government of India decided to build a public agricultural research system with ICAR as an apex body to plan, coordinate, and undertake research across commodities. Animal husbandry, fisheries, aquaculture, and many other enterprises integral to agriculture, were also brought under the umbrella of ICAR. Now, the system has grown into one of the world's largest networks of agricultural R&D, education, and extension institutions. Currently, ICAR is managing R&D activities in 102 institutions that include 65 research institutions, four deemed universities with research facilities, 14 National Research Centres, six National Bureaux, and 13 Project Directorates. ICAR is also playing a major role in the promotion of excellence in higher agricultural education by mentoring and providing financial support to 71 State cultivators under Agricultural Universities. In addition to research and education, ICAR also supports technology assessment, demonstration, capacity and Co-operative got a boost financing and an taken up to bring changes in the support system. development activities through a network of 11 Agricultural Technology Application Research Institutions and 721 Krishi Vigyan Kendras (KVKs) across the country. KVKs are small entities at the district level that perform frontline extension activities and are responsible for the implementation of 'Lab to Land' programmes. The first KVK was opened in Pondicherry in 1974 on the recommendation of an expert committee (1973), constituted to suggest ways for the institutionalisation of agricultural extension at a national level.

To strengthen the agricultural research network, it was imperative to develop a network for higher education in agriculture and allied sciences. In 1948, the country has only 17 agriculture colleges that were working under the administrative control of agriculture departments of respective States. During 1948-49, the then Chairman of the University Grants Commission Dr Sarvepalli Radhakrishnan advocated opening rural universities for

scientific training and skilling of rural youth. Pandit Govind Ballabh Pant, the then Chief Minister of Uttar Pradesh, acted on his call and deputed an expert committee to the USA to study the working of Land-Grants Universities and recommended a model for agricultural universities in India. Subsequently, acting on the recommendations of the committee, the Government of Uttar Pradesh decided to establish a large and integrated State Agricultural University in Rudrapur. The huge campus was inaugurated on 17 November 1960, by the then Prime Minister Pandit Jawaharlal Nehru as 'Uttar Pradesh Agricultural University'. This was the first agricultural university of India that laid a strong foundation of higher agricultural education with excellence. Later, it was renamed Govind Ballabh Pant University of Agriculture & Technology, and also played an important role in the success of the Green Revolution. During the Fourth Five Year Plan (196065), seven State Agricultural Universities (SAUs) were established in Uttar Pradesh, Orissa, Rajasthan, Punjab, Andhra Pradesh, Madhya Pradesh, and Karnataka, besides higher education, the wide network of SAUS is currently addressing State-specific research and extension needs in close contact with farmer communities. Meanwhile, ICAR was also reorganised and revamped in 1966 to address emerging challenges at the national level. Administratively, it became an autonomous body under the Government of India, and all research institutions/stations under various central commodity committees were brought under its umbrella. In 1965, ICAR initiated a novel concept of ‘All India Coordinated Research Projects’ (AICRPs) with a specific mandate- 'To conduct operational research and multi-location trials on developed technologies to identify technical, financial, managerial, and social constraints for better market acceptability 10 technologies'. Currently, 60 AICRPs are dedicated and functioning towards the improvement of various crops, livestock species, fisheries, and many other commodities importance.

Creating Milestones

Since the post-Green Revolution period, agricultural R&D mainly focused its efforts on issues that were critical to sustaining food security and efficient use of natural resources. In attempting so, an array of improved varieties of various crops were developed with desirable characteristics, such as high-yield potential, resistance to pests and diseases, tolerance to biotic and abiotic stresses, and better nutritional qualities. Some landmark varieties with far-reaching impacts were developed under the leadership of ICAR, such as 'HD' series of wheat varieties developed by IARI, New Delhi These varieties are high-yielding, rust-resistant, and scientists also added the attribute of 'climate adaptability’ in the latest varieties. The 'HD' series of wheat varieties now covers nearly 140 lakh hectare area out of 317 lakh hectare of wheat growing area in the country. Per hectare productivity of wheat has now sky-rocketed to

3,424 kg, which was just 669 kg during 1946-47 The nation harvested a record 110 million tonnes of wheat during 2020-21 (4th advance estimate). In rice, other than high-yielding, specific varieties were developed to perform well under drought or water-logged conditions. However, Basmati rice varieties, developed by IARI, won worldwide acclaim and popularity due to their exquisite aroma, flavour, and texture. The Basmati variety ‘Pusa-1121' has earned the unique distinction of being the longest grain' variety in the world with an exceptionally high cooked kernel elongation ratio of 2.5 and volume expansion more than four times. India could earn equivalent to Rs 33,000 crore of foreign exchange by exporting basmati rice during 2018-19. Backed by S&T interventions and improved varieties, India harvested a record 122.27 million tonnes of rice during 2020-21 (4th advance estimate).

To attain self-reliance in oilseeds production, agricultural R&D was oriented towards increasing per hectare productivity by various S&T interventions. The recent introduction of exotic oil palm as an oilseed crop by developing production technologies suitable to Indian conditions has shown promise. Earlier. the introduction and popularisation of soybean in suitable regions have successfully contributed to the kitty of edible oils. Due to consistent efforts, oilseed production in the country has reached a record of 36.10 million tonnes during 2020-21 (4 advance estimate). Special intervention made to raise the production and productivity of pulses has led to record production of nearly 26 million tonnes in 2020-21 (4th advance estimate). A mission mode approach was adopted to raise the production of horticultural crops mainly by the introduction of new varieties, improved package of agricultural practices, expansion of the area, and regeneration of old/unproductive orchards. Currently, India ranks number one in the productivity of banana, grapes, papaya, cassava, and green peas Total horticultural production is estimated to be 329.86 million tonnes (highest ever) during 2020-21 (2nd advance estimate). A significant increase in production is registered over the previous year in nearly all categories of horticultural crops, such as fruits. vegetables, plantation crops, spices, and medicinal and aromatic plants. In the latest development, scientists have developed bio-fortified varieties of some major crops, which are 1.5 to 3.0 times more nutritious than the traditional varieties. Recently, the Prime Minister dedicated 17 such varieties of eight crops to the nation.

During the 1950s and 1960s, just like food grains, India depended heavily on the import of milk to meet national demand. To attain self-reliance, an ambitious programme, called 'Operation Flood', was launched in 1970 that addressed production and productivity issues with major reforms in the marketing of milk and milk products. Soon. the efforts paid dividends and in 1998, India became the largest producer of milk in the world, surpassing the

USA. The transformation, widely known as 'White Revolution', is still making waves with current milk production of nearly 200 million tonnes and per capita milk availability crossing 400 gm per day. Advances made in animal breeding, reproduction, health, and nutrition have made seminal contributions in sustaining the white revolution. Similarly, the targeted programme of Blue Revolution transformed the fisheries sector with an all-time high production of nearly 14.16 million tonnes between 2019 and 2020. On the global map, India is the second-largest-aquaculture-producing country and the third-largest fish producer.

Way Forward

Despite splendid growth, Indian agriculture is facing some major challenges such as small and fragmented land holdings, post-harvest losses, and poor market infrastructure Recently, the Government has launched several new schemes and programmes to address such issues by adequate fund allocation and devising innovative measures that include cutting-edge S&T interventions. For example, Artificial Intelligence and Machine learning are paying the way for intelligent farming, and the use of IoT-enabled sensors to prevent excessive use of harmful chemicals. Specialised drones and robots are poised to revolutionise modern farming. Drones, aerial as well as ground and satellite imagery based, are helping farmers to remotely monitor crops, diagnose issues, and also make informed decisions regarding crop protection and nutrition. Digital transformation is changing the face of agriculture and farmers by providing the right knowledge, resources, and technology on a real-time basis. Online marketplaces (e-Mandis) and regular market updates are empowering farmers to maximise their income. Recent thrust and support to agri-startups are helping the promotion of agriculture as an enterprise with attractive returns However, the future of Indian agriculture lies in the development of sustainable agriculture, which means development policies related to agriculture and farmers must include conservation of natural resources and create an enabling policy environment for future agriculture Generation and distribution of appropriate technologies, improvement in support services, and enhancement in physical infrastructure are other issues that need immediate attention. Integration of resources. technologies, knowledge, and policies are paving the way for better agriculture and a brighter tomorrow.