Agricultural Research for Food Security and Income

J. P. Mishra

With the increasing population and diversifying dietary demand under the developing economies like ours, the demand for food and other related commodities has been increasing steadily. The agriculture research has been the saviour for addressing the food security, income to farmers and those who work on the farms and farm related activities and on a larger note to sustainability of the natural resources for the very sustenance of the mankind. By addressing the pre-harvest and post-harvest management, it ensured the three facets of food security-availability, access and affordability.

In an agrarian economy like ours, speedy and sustainable development of agriculture and allied activities is the potent tool for the progress of the country. Agriculture has positioned itself more relevant for meeting the food, feed, fodder, fuel, fibre and timber demand of increasing human and animal population. Since primitive time, agriculture and hunting have been the major source of livelihood, food and income which gradually diversified towards allied activities basically dependent on agriculture for raw materials like textiles, dairying, logging, fishing, etc. The agriculture, however, enjoys the vitality in entirety for ensuring food security to all on a given geography and income for those who adopt or opt it as a primary occupation. With the increasing population and diversifying dietary demand under the developing economies like ours, the demand for food and other related commodities has been increasing steadily. On the other side, the base resources for agriculture like land and water, being finite, are not available beyond a point. This competition in production and resource use caused larger sustainability issues over time. The agriculture research has been the saviour for addressing the food security, income to farmers and those who work on the farms and farm related activities and on a larger note to sustainability of the natural resources for the very sustenance of the mankind. By addressing the pre-harvest and post-harvest management, it ensured the three facets of food security-availability, access and affordability.

Pre-Independence Agricultural Research

The process of the development of agricultural research system in India started as early as in 1869, when Lord Mayo, Governor General in India prepared to create Department of Agriculture in the Government of India with counterparts in the provinces. The foundation for scientific research in

agriculture was laid in 1889 with the establishment of the Imperial Bacteriological laboratory in Poona (Pune), subsequently shifted to Mukteshwar in 1895. During the time of Lord Curzon, in 1905, the Imperial Agricultural Research Institute was established at Pusa, Bihar followed by a series of departments of agriculture and colleges in the different provinces, besides central institutions. Later, it was desired to have a coordinating unit. Royal Commission on Agriculture in 1926 proposed an Imperial Council of Agricultural Research (ICAR) to promote, guide and coordinate agricultural research throughout India. ICAR was registered as a society under the registration of societies Act 1860 in July 1929. The institute was shifted to New Delhi in 1935. At the time of establishment of the Imperial Council of Agricultural Research, there were also a few commodity committees. They primarily worked as advisory services to the government, but to a limited scale they have also taken up research work on specific crops like Cotton, Lac, Jute, Sugarcane, Coconut, Tobacco, Oilseed, Arecanut, Spices and Cashew nut, etc.

Post-Independence Agricultural Research

Rainfed agriculture dominated the independent India. To intensify the research on rainfed crops like cotton, Oilseeds and Millets, the Project for Intensification of Regional Research on cotton, Oilseeds and Millets (PIRRCOM) was established in different agro-climatic zones in 1954 and in 1957, All India Coordinated Research Project (AICRP) on Maize was started. The AICRP model proved successful. Subsequently, AICRPs on all major commodities, natural resources, farm machineries, livestock, home science etc. These projects are characterised by combining state-central efforts avoiding any duplication and waste of expenditure. Traditionally long duration tall rice varieties were being grown in India prior to 50s which were less responsive to synthetic fertilisers. As the use of synthetic fertilisers became popular after the World War II, India needed the varieties which respond to heavy fertilisation. The major breakthrough in rice varietal development happened in 60s with the help of International Rice Research Institute. It helped in evolving dwarf high yielding varieties by using the gene from semi-dwarf Chinese varieties. To give rice research a fillip, AICRP on Rice was launched in 1965. This worked as a coordinating platform for interdisciplinary and inter-institutional research on rice for improving the production, productivity and profitability. The most intensive rice breeding was initiated in 1965 with the development of Taichung (Native)-I from the semi-dwarf mutant. Padma and Jaya were the first varieties that emerged from the programme. Subsequently, several semi-dwarf varieties of high yield potential were released. The semi-dwarf varieties have been found superior in efficiency of grain production as compared to the tall traditional varieties. To accelerate the rice productivity, hybrid rice research was initiated during 1970. However, the intensified efforts were started from 1989. As a consequence, within a short span of 5 years, half a dozen rice hybrids were developed by public and private sectors. The first 4 rice hybrids were released in 1994. The number grew to 19 by the end of 2001. The crops under the category coarse cereals (maize, sorghum, bajra, barley ragi and small millets) were central for food security in arid an semi-arid regions of the country with low to lowest rainfall regions. In maize, over 230 varieties (composite and hybrids), were developed since 1957. These include 132 hybrids released after 1996 including 4 dozen public-bred single cross hybrids. The spread of modern varieties and hybrids of pearl millet and sorghum began in the mid-1960s. These developments led to substantial yield gains in these crops in arid and semi-arid regions and increased overall production of maize, sorghum and millets. The fruits and vegetables are integral to food and hence food security. The research on fruits and vegetables in India is steered by several institutes and AICRPs on fruits, vegetables, spices, tuber crops, potato, arid fruits, mushroom, floriculture, etc.

The success of the improved varieties emanated from the Government interventions for (i) higher investments during 70s in crop improvement programmes agricultural systems, both national and international; (ii) introduction and development of efficient seed systems during 80s and gradual inclusion of the private sector; and (iii) the liberalisation of the seed industry in the late 90s.

While new varieties and hybrids were vital revolutions in plant types much responsive to fertilisers and irrigations, they brought new challenges in soil and water management for production and protection. When the population was low, single cropping in a year was a rule rather

than exceptions. However, with growing population, multiple cropping became the order of the day. Consequently, the man and machine activities on land increased leading to soil and water issues. The huge land mass was rain dependent at the time of Independence as about 83 percent cropped area was unirrigated. Hence, the Government gave topmost priority to the development of irrigation projects from first 5-year plan onwards. Simultaneously, to provide the scientific solutions for moisture conservation, crop production, selections of varieties, crops and cropping systems, crop substitution, alternate land use, etc the AICRP on Dryland Agriculture (AICRPDA) was initiated in 1987. The *ex situ* rainwater management, integrated nutrient management, crop diversification, alternate land use, integrated farming systems, strategies for climate variability, etc were the thrust areas. The research on long term fertiliser experimentation, soil test crop response, micronutrients, salt affected soils, agro-meteorology and agro-forestry, etc were introduced to steer the research on specific areas to develop practices and protocols for higher production of food crops. Livestock and Fisheries research were also carried out simultaneously to develop new breeds, quality standards, strains and fingerlings, health and hygiene etc.

The research on farm implements and machinery was initiated in 1975 for development, testing and popularisation of need-based farm implements and machinery for different regions of the country which proved promising in enhancing the use efficiency and reducing the cost of cultivations besides, reducing the drudgery in farm operations. The frontline extension system in India started with the first Krishi Vigyan Kendra (KVK) established in Puducherry in 1974. At present each district in India has one KVK, many big districts are having 2 KVKs. Today, 113 research institutions and 57 AICRPs and 25 Network Projects are functioning under ICAR. Besides, 718 KVKs are the gateway of frontline extension at district level.

The State Agriculture University (SAU) play complimentary responsibility for location-specific agricultural research. The University Education Commission headed by Dr. S. Radhakrishnan, in 1949, recommended to establish the rural universities on the pattern of land grant college philosophy of USA. Subsequently, the first SAU was established at Pantnagar in 1960. Today, the National Agricultural Research System is a two-tier system, comprising of ICAR at National level, and State Agricultural Universities (SAUs) at state level.

The developments of agriculture and self-sufficiency in food grain production is due to integration of both the national (ICAR) and state (SAUs) joint efforts. The concerted research efforts could develop the technologies and package of practices for soil productivity, water management for storage, expansion and efficiency. These were central in transforming a food deficit nation into food surplus and net exporter after independence. The declining size of farms, depleting resources and escalating costs of applied inputs and farm labourers opened new challenges for agricultural research for enhancing the production and monetary return from farming. The strong linkages with international research organisations and scientific institutions, located in different regions of the world also played critical role in vanishing the food insecurity from the country. The research system in India rose to all the occasions of need and solved the challenges emanating from climate change, insects-pests and virus infections in crops and livestock and helped eradicating them to sustain the food security. Today, we have a state-of-the-art facility for advance research in plant, livestock and fisheries. The recent advances in basmati rice, multiple disease resistance in wheat, tomato, rice, etc along with genomics in pigeon pea, chickpea, rice, tomato, etc are some examples to cite.

Research for Food Security: Post-Independence

While pre-independence periods were marked with severe famines and stresses, the hurtful memories of the mid-'60s still haunts many when, after two successive severe droughts in 1964/65 and 1965/66, India needed American wheat under PL 480 on at relatively low prices and on rupee payment due to lack of foreign exchange to buy food in the world market. The transaction with US turned sour at early stage due to India's criticism of American bombings of Hanoi and Haiphong in the course of the Vietnam War. The country was labelled with much undignified remarks of 'ship to mouth' when imported wheat used to be directly distributed from port to households. The then Prime Minister late Lal Bahadur Shastri gave a call to skip one day meal in a week to help saving foodgrains. While India was struggling to provide two square meal

a day to its people, the Norman Ernest Borlaug's new semi-dwarf, disease-resistant varieties, revolutionised the spring wheat in Mexico making Mexico fully self-sufficient in wheat production and net exporter in 1963. At the same time, in India, the imports were being made as a contingent measure to feed the population and Dr. C. Subramaniam, the then Union Minister for Agriculture and Dr. M S Swaminathan, former DG, ICAR along with team of scientist after assessing the possibility of increasing the production of wheat through the use of Mexican wheat varieties, introduced 5 dwarf varieties, Lerma Rojo 64-A, Sonora 63, Sonora 64, Mayo 64 and S 227 along with about 200 other breeding lines in 1963. These varieties were stiffer and shorter and relatively photo-insensitive and capable of high yields at high doses of fertilisers, irrigation and other inputs. The success in rice varietal development and other commodities like maize, jowar, bajra, small millets, etc caused significant growth in the production of foodgarins production. However, oilseeds and pulses remained our pain points.

By the time the country was readying itself to reap the benefits of technological advancement due to research outputs in agriculture and allied activities, the population increased by 1.5 times adding 18.55 crore more people with an annual growth of about 1.9 percent per year. The most satisfying achievement on agricultural research front was that the growth in wheat in terms of per capita availability outpaced the growth in population during 1951-1971 period (Figure 1). This was the beginning of resounding confidence amongst the people that agricultural research and technological development can outpace the increasing demand for food and related items required for growing population. The trend continued in subsequent decades also.

Post green revolution, the white revolution happened in the country which augmented the milk production. The research in cross-bred breeds and their feeding and shelter management helped sustaining the growth in milk production. The research in small ruminants, poultry and fisheries for breeding, feed and nutrition, diseases management helped these sectors grow in leaps and bounds. The production of milk and milk products, meat, egg and fish has increased multiple times since 1950-51 (Table 1, see on page no. 20). It all happened due to improved breeds, quality protocols for feed and feeding of milch animals, poultry and fisheries. The diagnostics and vaccines developed after the concerted research have helped not only controlling the diseases but also eradicated some of the dreaded diseases from the country such as Rinderpest, Contagious bovine pleuro-pneumonia, African house sickness and Dourine – a parasitic disease. The country is poised to be FMD Mukta by 2030. Several silent revolutions, in field crops, happened in Indian agriculture after the green revolution due to introduction of new varieties and

Figure 1: Growth Rate (per cent/annum) in availability of foodgrain and population

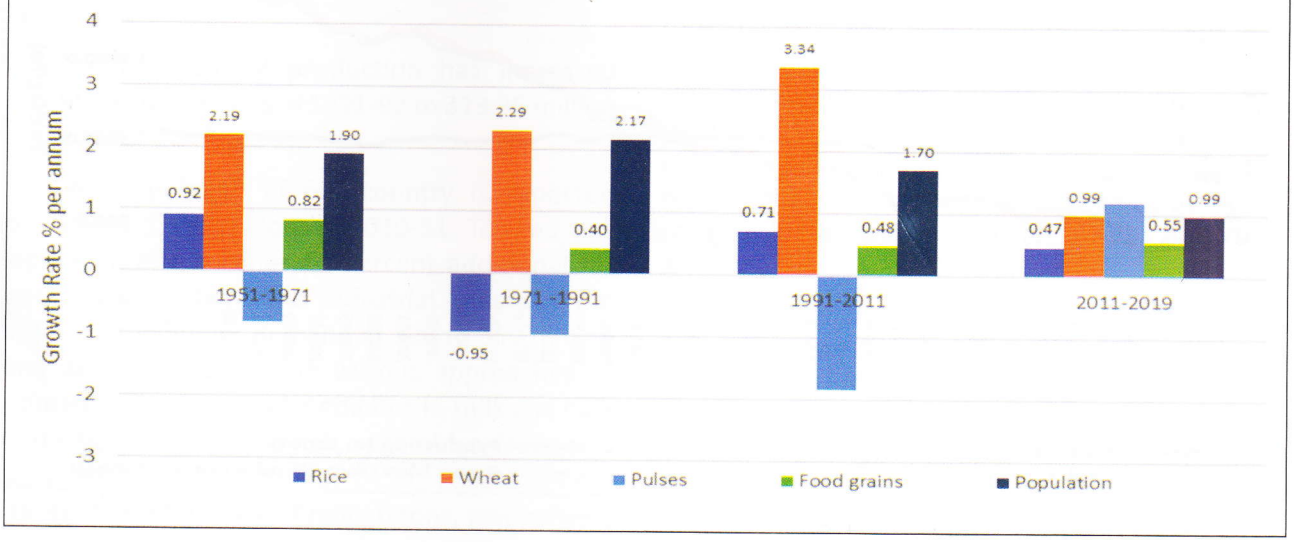
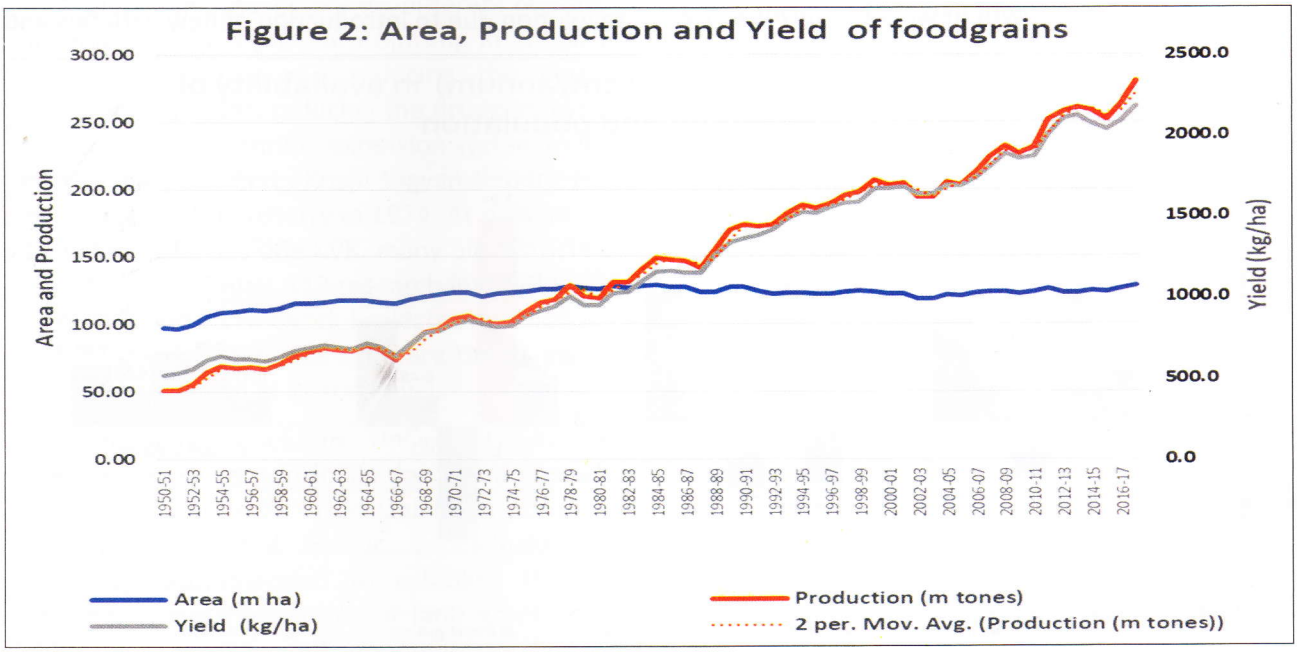


Table1: Increase in production of food grain and other commodities due to technological advancement

Item	Production (m tones)		Times Increase (X)
	1950-51	2019-20	
Food grains*	50.83	295.67	5.82
Pulses*	8.41	23.01	2.74
Oilseeds*	5.16	33.50	6.49
Cotton*	0.52	6.13	11.79
Sugarcane*	57.05	358.14	6.28
Horticulture@	96.56 (1991-92)	313.35	3.25
Milk#	17.00	187.70	11.04
Fish#	0.75	13.42	17.89
Egg (no. in billion) #	16.1(1985-86)	103.30	6.42
Meat#	1.9 (1998-99)	8.11	4.27

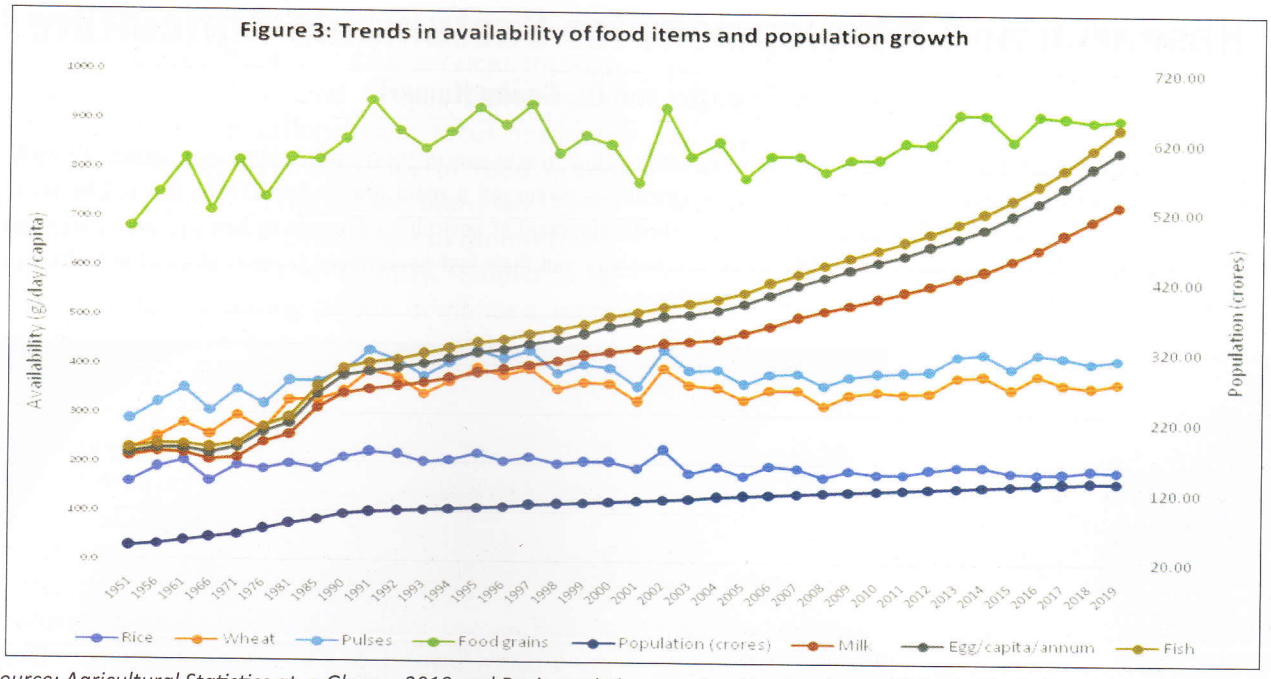
* III Adv. Estimate, 2019-20, @I Adv. Est., 2019-20; # figures, 2018-19
(Source: Ministry of Agriculture and Ministry of Fisheries and Animal Husbandry & Dairying

improved production technologies. In 1986, the Government introduced Technology Mission on Oilseeds (TMO) to enhance the oilseeds production through technological interventions and area expansion. Later, pulses were included under TMO to make it TMOP. A significant boost in the production of oilseeds was witnessed post Technology Mission on Oilseeds which created enabling environment for adequate funding support to research and development. Driven by area expansion, use of quality seeds of HYVs and management of other applied inputs, the production got doubled in 10 years during 1986-1996. The TMO in 1986 could deliver the desired result due to defined role and dedicated funding mechanisms for Research and Development. The new HYVs in soybean, R&M, Groundnut and other oilseeds with concerted efforts on the seed development and promotion could transform the oilseeds production within 10 years. Afterwards, the stagnation in area of oilseeds was seen and growth in production dipped although the productivity has shown a remarkable increase of 37 percent during 1997-2017. As the luxury of bringing more area under oilseeds has almost dried up, the past approach of TMOP of area expansion will not work anymore. The data on area under cropping reflected that the area remained almost constant since 1975-76. It is the growth in productivity due to technological advancement for varieties and production techniques, which



Source: Agricultural Statistics at a Glance, 2019

Figure 3: Trends in availability of food items and population growth



Source: Agricultural Statistics at a Glance, 2019 and Basic statistics on animal husbandry and fisheries (M/o FAHD)

has helped raising the production (Figure-2). The real benefits of enhanced production have been visible with the increase in per capita availability of foodgrains and other commodities inspite of higher growth in population (Figure 3). In the recent times, the significant increase in pulse productivity, due to introduction of new varieties in the seed system, has helped country attaining near self-sufficiency in pulses production. This is the most recent testimony of research contributing for the food security of the nation and also import substitution. The development of new varieties with multiple resistance for diseases and abiotic stresses in horticultural crops could boost the production surpassing the foodgrains production in the country.

The horticultural production has increased from 96.56 million tons in 1991-92 to 313.35 million tons in 2019-20 (Table 1).

The population of our country is expected to reach at 1.531 billion by 2030-31. To feed this population and another 40 percent additional for seed, feed, wastage and industrial uses put the projected foodgrains demand at 326 to 350 million tons depending upon the various approaches of estimates. The demand for edible oils, milk and milk products, meat, egg and fish, vegetables, fruits and sugar has been projected at 24.31, 256.43, 29.45, 316.33, 178.74 and 44.77 million tons, respectively in the year 2030-31 (NITI Aayog, 2018). These have to be achieved with declining per capita availability of land, water and other finite natural resources. The climate change effects are looming large on the entire agri-food system. The strategy revolves around raising productivity for the farmers' welfare and reduce agrarian distress by enhancing the income of the farmers. The performance of Indian agriculture during the last 7 decades has been remarkable owing to dynamism in the research and extension system of the country which is capable of absorbing immediate shocks and emerging challenges with innovative technological advances and breakthrough as has happened in the past. The pursuit of making India Aatmanirbhar will continue with much concerted efforts in agricultural research for developing new varieties, production and protection technologies and quality and safety standards for the Indian products. There is necessity to invest in the R&D for infrastructure and human resources development to make India globally competitive and sustain the food and nutritional security for all and income to farmers and rural workers.

(The author is Officer on Special Duty, Policy, Planning & Partnership, ICAR. He is Former Adviser (Agriculture), NITI Aayog, and Former Deputy Commissioner/ OSD & Agriculture Commissioner, DACFW, M/o Agriculture, Government of India. Email: jp.mishra67@gov.in. The views expressed are personal.)