JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Azadi Ka Amrit Mahotsav – Agriculture Sector of the economy and its performance

Jyothi D, Dr Danangaya K B

Abstract

Agriculture is the foundation of the civilization, culture and heritage of India. About half of the Indians derive their livelihood from agriculture and allied activities. It is one of the oldest systems of the world characterized by its diversity and heterogeneity, unorganized and stressed on account of natural and anthropogenic vagaries from 'seed to market'. Historically, stressed natural resources due to unfavourable weather, monsoon and natural calamities resulted in crop failures leading to food shortage that made serious impacts on the civilization. Post-Independence, the Indian agriculture transformed from a food-scarce to food-exporting country primarily due to science led innovations that caused multi fold increase in the agricultural production from 135 million tons in 1950/51 to over 1300 million tons in 2021/22 in spite of increasing abiotic and biotic stresses and depleting along with deteriorating natural resources.

India has about 160 Mha of arable land, second largest after the United States of America and experiences all the 15 prominent climates with 46 out of 60 soil-types that exist on the earth. About 50% of its total geographical area is cultivated which ranks it among the top user of the land for agriculture. It is the critical sector of economy for the sustainable and inclusive economic growth of the country. The sector engages 49.6% of the workforce, often seasonally, under-employed, under-paid and accounts for about 17% share in India's Gross Domestic Product (GDP). *Vrikshayurveda* discusses the science of plant life such as procuring, preserving and treating of seeds before planting; selection of soil and nourishment; and plant protection from internal and external diseases.

In the co-existence of uncertainties of weather and declining soil health, increasing atmospheric temperature and emergence of more virulent pests and pathogens, the science-led agricultural development transformed India from an acutely food-scarce and food shortage to food sufficient to food surplus and food exporting country. The overall food grain production increased from 51Mt in 1950-51 to over 314 Mt in 2021-22. The production of food grains increased over 6 times, horticultural crops by 11 times, fish by 18 times, milk by 10 times and eggs by 53 times since 1950-51, thus making a visible impact on the national food and nutritional security (Pathak and Ayyappan 2020). However, amongst the few sectors that made impressive progress during past 75 years of India' independence, agriculture is confidently the one. This has been proven

time and again when all the sectors fall short, agriculture came as saviour. The recent performance during global pandemic COVID-19 is the best testimony.

Introduction

Indian agriculture is as diverse as the country itself. It encompasses different agro-ecosystems based on commonality of climatic, soil, geological, vegetational and other natural features, which decide the diversity of habitats, variety of crops and livestock that has been developed over the millennia. India is one among the earliest regions on earth, where settled agriculture began about 11,000 years ago. The Indian region is one of the world's 8 centres of origin of crop plants. About 166 crop species and 320 wild relatives of crops have originated here. Genetic diversity within each species is also tremendous India also has the world's largest diversity of livestock. All the world's eight buffalo breeds are found here. More than mere physical adaptation, a host of economic, cultural, religious, and survival factors have played a role in this diversification. Several varieties of rice and other crops, for example, were grown in many parts of India just for their use during festivals, marriages or other auspicious occasions; several others were grown for their taste, colour or smell; and others for their pesticidal or soil-fertilization characteristics.

As the climate varies across the regions, so is the water availability in the country. The supply of water for agriculture is highly seasonal and depends mostly on the southwest monsoon, and partly on the northeast monsoon in a few southern states. The water availability for irrigation also varies greatly. For example, in the IGP region, because of the perennial rivers flowing from the Himalayas and recharged groundwater, adequate water for irrigation is available. However, the groundwater is depleting rapidly raising concerns about future crop productivity and sustainability. Contrast is true for peninsular India, where highly seasonal rainfall regime, lack of perennial water streams and hard rock formations limits the groundwater aquifers recharge adequately. India possesses large areas of highly fertile alluvial soils such as in the IGP, and relatively productive black soils of the Deccan plateau and the red-to-yellow lateritic soils.

The cropping is rather diverse in the country with about 60 crops grown in some states. The number may be even higher if localized cultivated crops are accounted for. In the order of area and production, rice is the foremost cereal crop of kharif season and wheat of rabi season. Other important cereals are maize,sorghum, pearl millet and finger millet. Another important category of food crop is pulses dominated by chickpea. These are the important source of plant protein for most Indians. The oilseeds that provide edible oil is another important group of crops. Amongst the 9 oilseed crops, soybean, rapeseed and mustard and groundnut are the important ones. The food and non-food crops that are used by industries to process and produce finished products include sugarcane, cotton, jute, mesta, tobacco, tea, etc. Tomato, onion and potato (TOP); and other green vegetables such as brinjal, okra and squashes as well as fruits such as mango, banana, mandarin orange, papaya and melons are non-staple crops. Various spices such as chilies, turmeric and ginger are cultivated for domestic as well export purposes with a long history and acknowledgement worldwide.

Animal husbandry is an integral part of India's agricultural system. Animal genetic resources are nation's traditional strength and provide a good option to manage agriculture sector in more profitable and sustainable manner. India has the largest bovine population of the world. Mixed farming of crops and livestock is the predominant farming system in India. Total livestock population is 536 million in India with 36%

constituted by cattle and 20% by buffaloes. Total milk production in India was 210 Mt in the year 2021-22 with per capita milk availability of nearly 400 g day-1. The major portion of the milk produced in India is contributed by small and marginal farmers. ICAR has characterized the livestock population of India in their natural home tracts and registered 197 breeds. This includes 50 breeds of cattle, 17 breeds of buffaloes, 34 breeds of goats, 44 breeds of sheep, 9 breeds of camel, 7 breeds of horses, 19 breeds of chicken and 3 breeds of dog.

Fishing is practiced along the entire length of India's coastline and in the, reservoirs and lakes. The marine and inland fisheries are contributing production of 3.8 Mt and 1.3 Mt, respectively. Major marine fishes include sardine and mackerel whereas the freshwater catches are dominated by carps. Aquaculture of fish and shrimp is becoming increasingly significant, which at present contributes over 9.0 Mt.

Landmark achievements in Indian agriculture

In the year 1950-51 for which the data of agricultural production of majority of the commodities are available by the authorized sources, we have been producing about 135Mt from agriculture and allied sectors. In 2021-22, total production of food and non-food items was about 1300 Mt. This achievement is one amongst the very few noticeable landmarks in the history of Independent India. There has been multi-fold increase in the production of all the commodities, in spite the net sown area remaining almost constant at about 140 Mha.

India now is one of the largest agri-producers globally, ranking within the top 5 countries.These have enabled not only self-sufficiency in food, but also export of agri-commodities worth US$ 50 billion. Production of most of the agricultural commodities has increased by 6 to 68 times with only 1.3 times increase in area (Table 2). Thus, the country, which was food scarce till 1950, transformed itself into food shortage by 1960, food sufficient by 2000, food secured by 2010 and food surplus by 2010 onwards (Fig. 2). During the ongoing COVID-19 pandemic situation also, food production systems have been meeting the demands, with innovative interventions across the value chain. There are also indications that the greenhouse gas (GHG) emission intensity in agriculture is reducing and fertilizer use efficiency is improving in recent years (Pathak and Ayyappan 2020). A blend of science, technology, extension and policy has contributed in this journey of transforming the country from food scarce to food surplus nation.

Table 1: Production of agricultural commodities and cultivated area in the country in 1950-51 and 2021-22

Commodity	1950-51	2021-22	Times Increase
Food grains (Mt)	51	314	6.2
Vegetables & fruits (Mt)	25	333	13.3
Milk (Mt)	17	210	12.4
Egg (billion)	1.8	122	67.8
Fish (Mt)	0.8	14.20	17.8
Net sown area (Mha)	130	140	1.1
Gross sown area (Mha)	150	198	1.3

From the Table it could be illustrated that there is 6.2 times increase in the production of food grains. Food grain production was 51 Mt in 1950-51 that drastically increased to 314 Mt in 2021-22.There is 13.30

times increase in the production of horticulture produce which was majorly vegetables and fruits. Production of fruits and vegetables in 1950-51 was 25 Mt that increased to 333Mt in 2021-22.Production of Milk was 17 Mt in 1950-51 which increased to 122 Mt in 2021-22.There was 12.4 times increase in production of Milk. Similarly there is 67.8 times increase in production of egg, 17.8 times increase in production of fish. There is less increase in net sown area and grass sown area which is only 1.1 times ad 1.3 times increase respectively.

Table 2:Growth in GVA and Terms of Trade in different periods

Sub-Sector	**Trend Growth rate %**			
	1950-51 to 1964-65	1967-68 to 1990-91	1990-91 to 2004-05	2004-05 to 2020-21
Agriculture & Allied	2.54	2.53	2.74	3.56
Non-Agriculture	5.86	5.31	7.39	6.90
Human Population	2.03	2.22	1.88	1.38
Bovine Population	0.93	0.91	0.18	0.20
Crops	2.66	2.75	2.71	2.40
Livestock	2.64	2.69	2.73	6.88
Fishing and Aquaculture	4.79	3.66	4.40	6.72

Table 2 illustrates Gross Value of Agriculture in terms of trade during different periods in the country. It is observed that there is an increase of 3.56 percent in the GVA of agriculture and allied sector during the 2020-2021 from 2.74 in 2004-05.There is an increase in the GVA of Bovine population from 0 .18 to 0.20 from 2004-05 to 2020-21.There is a decline in the GVA of crops from 2.71 to 2.40 from the period of 2004-05 to 2020-21.There is a robust increase in the GVA of Livestock, Fishing and Aquaculture from 2.73 to 6.88 ad 4.40 to 6.72 respectively from 2004-05 to 2020-21.1965-66 and 1966-67 were very serious drought years, which brought down agri output drastically (-12.5%).

Table 3: Growth Rate in OUTPUT of Different Groups of Crops and Other Agri Products

Sub-Sector	**Trend Growth rate %**			
	1950-51 to 1964-65	1967-68 to 1990-91	1990-91 to 2004-05	2004-05 to 2020-21
All Crops	2.81	2.63	2.29	2.65
Rice+Wheat+Maize	4.28	3.36	1.38	2.37
Jowar+bajra+ragi+ small millets	2.38	0.86	-1.62	-1.94
Pulses	1.68	0.98	0.20	4.04
Oilseeds	3.03	2.87	0.47	1.34
Fruits &vegetables	1.73	3.46	4.70	4.84
Milk Group	1.21	5.02	3.96	5.09
Egg	3.42	6.76	4.11	5.38
Meal	1.62	4.03	3.37	7.18
Fish	4.77	3.65	4.35	6.74

From Table 3 it is observed that in the first 15 years of the plan period show highest growth in crop output with the low base effect. In the beginning of Green Revolution superiority of Rice and Wheat

established. The production of Millet and Pulses suffered during this period. Millets show falling growth and reached negative territory in recent years. The growth of Pulses revived after 2004-05 which lowered dietary diversity within food grains. NFSM and BGREI raised growth of fine cereals and pulses. Nutri cereals decelerated through out and reached negative zone. The growth of Oilseeds lost momentum in the beginning of 1991 leading to heavy import dependence. Inclusion of 1965-66 and 1966-67 alter pattern of trend. Two drought years put country into despair, which seems difficult to overcome. Green Revolution Technology came to the rescue in crop production.

Policy innovations in Agriculture

The agricultural transformation in India from food deficit to food surplus in the past 75 years has seen many bold and dynamic policy interventions. Immediately after the independence, the establishment of SAUs on the land grant pattern of the USA was the policy milestone that resulted into one of the largest agricultural research systems in the world. Imports of seed of dwarf varieties of rice and wheat was another policy decision in 1964 onwards that helped furthering the crop sciences in the country. The policies related to regulations and facilitation of germplasm exchange helped new seeds and planting materials for the research system. Several acts and institutions came into being, modified and remodified with the passage of time to attract scientific research in agriculture, promote public and private investment and facilitate the farmers and others involved 'in' and 'for'

agriculture. The Cooperative Societies Act, passed in 1904, and its subsequent reforms for credit support to the farmers was a major milestone. Post-independence, several state owned commodity institutions were brought under ICAR to reorient and refocus their strength for national and regional aspirations. The input and technology intensive Green Revolution accelerated the need for financial support for agriculture. In the year 1974, the commercial banks were advised to raise the share of the 'priority sectors' including agriculture in their aggregate advances to the level of 33.3%. Another landmark policy decision that helped technology reaching directly to farmers by the technology evolver was taken in 1974 for the establishment of KVKs, which were later broadened to at least one in each district of the country. Further efforts were done by attaching each district with a commercial Lead Bank. The Commission for Agricultural Costs & Prices (CACP) and the Food Corporation of India (FCI) were established to assist the farmers with price support operations and ensure the productivity gains reaching the consuming sector through the Public Distribution System (PDS). In the year 1982, the National Bank for Agriculture and Rural Development (NABARD) was established to undertake the agricultural credit related functions of the Reserve Bank of India. Public institutions both at the centre and states have helped in minimizing risks and costs of inputs used for higher profit realizations. Subsidies and waivers have been the prime instruments for providing such benefits to the farmers. The other institutional intervention to support farmers has been the direct income transfer through the Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) scheme. Along with enhancing food production, the export promotion and import substitution are the focus through local to global and one district one product initiatives. The Council has identified process able and high-yielding varieties of various crops and fruits matching with the consumer preference and markets to enhance the export of potential commodities (ICAR 2021). The rise of new generation entrepreneurs or start-

ups, since last decade, led by innovative ideas to solve the problems along with ethical business practices are playing in profound ways. Agriculture and allied sector have been witnessing emergence of several start-ups, commonly termed as "Agri-startups", which help developing products and services to bring efficiency in the value chain. Many of these start-ups are using new generation IT tools like, artificial intelligence (AI), Internet of Things (IoT), imaging & sensors, remote sensing, drone, data analytics, blockchain technology, etc. in agriculture and allied sector for improving yield, efficiency and profitability. ICAR has established 50 agri-business incubators since 2016 and supported 1476 start-ups/entrepreneurs/incubates during 2014-20.

Table 4: State-wise Growth in Gross Value Added in Crop Sector and Total Agriculture 2011-12 to 2019-20

	State	Growth Rate (Avg Y-o-Y change)	
		Agri and allied	Crop
1	Kerala	-2.19	-3.63
2	Bihar	2.02	-1.26
3	Chandigarh	2.03	-1.19
4	Uttarakhand	0.88	-0.78
5	A&N Islands	1.99	-0.50
6	Arun. Pradesh	3.46	-0.47
7	Goa	2.66	-0.03
8	Jharkhand	1.96	0.08
9	Punjab	2.19	0.69
10	Tamil Nadu	4.96	0.91
11	**Haryana**	**3.50**	**1.05**
12	**J&K**	**2.89**	**1.50**
13	**Maharashtra**	**2.88**	**1.98**
14	**Rajasthan**	**4.69**	**2.01**
15	**West Bengal**	**2.60**	**2.09**
16	**Uttar Pradesh**	**2.72**	**2.27**
17	**Assam**	**2.60**	**2.95**
18	**Gujarat**	**4.56**	**2.96**
19	Karnataka	3.80	3.38
20	Mizoram	15.48	3.45
21	Meghalaya	4.04	3.58
22	HP	4.14	3.62
23	Chhatisgarh	4.79	3.75
24	Odisha	4.54	3.98
25	Nagaland	1.65	4.19
26	Andhra Pra	8.92	5.41
27	Telangana	6.50	6.59
28	Sikkim	6.78	6.59
29	Tripura	8.02	6.87

From Table 4 it could be observed that in most states Growth Rate of total agriculture is robust but GR of Crop sector varies from -3.6 to 1% in 10 states out of 29 states. Only 11 states out of 29 states show more than 3% Growth Rate in income from crop sector. Even here, the major source of growth is due to horticulture. Farmers

in most cases identify their income with income from crop sector only. Bulk of farmers experienced negative or meagre growth from crop sector. Share of income from crop sector in 2011-12 is 65.4%. where as in 2018-19 is 55.3%. which indicates that crop sector income is squeezing. This is a wake up call for crop sciences and policy makers to make necessary policy changes in Agriculture.

Emerging challenges

With the expected population of over 1.6 billion and annual food demand of 400 Mt by 2050, the country requires minimum 4% annual growth in agriculture. The changing macro- and micro-economies will also impact the demand and behavioural changes for food. There would be substantial increase in demand for quality products of fruits/vegetables and livestock. The dietary pattern of eating less with bio-enriched quality food could be another major shift. The challenges of environment protection and globalization shall put tremendous pressure on Indian agriculture. Climate change induced impacts on agricultural productivity is the most imminent of such challenges. The temperature is rising and becoming highly variable. Amount, intensity, variability and extreme events of rainfall are rising, while the duration of rainfall is reducing. Perceptible negative impacts are projected on production of food grains, livestock as well as aquatic systems, both quantitatively and qualitatively.

Sustainable intensification of land resources is inevitable for food security of increasing population. India has 121 Mha i.e., 36% of the geographical area degraded with soil erosion, salinity, alkalinity, acidity, water logging and other edaphic stresses. With 4% of world's renewable water resources, the country has only 43 Mha fully irrigated, 23 Mha partially irrigated and 74 Mha rainfed. In the recent past, both drought and floods have been seen to be stress factors in farming. India's rechargeable annual groundwater potential is around 432 billion cubic metres (BCM), with over 90% utilised in some parts of the country, as can be seen from the depletion of the groundwater table in several states of Punjab, Haryana, parts of Rajasthan, Gujarat, western Uttar Pradesh, as also in the Deccan plateau. With multiple activities on the land resource including farming practices, nutrient deficiencies of different kinds are being increasingly reported. Annually, 8-10 Mt of NPK is mined from soil and 93, 91, 51 and 43% soils are rated low in nitrogen, phosphorus, potassium and zinc, respectively. Fertilizers, therefore have played a crucial role in enhancing crop production and globally, 120 Mt of N fertilizer is used in agriculture, while in India, the consumption is about 17 Mt annually. However, nearly half of the fertiliser N applied is leaked into the environment through volatilization, leaching or emissions resulting in multiple adverse effects on terrestrial and aquatic systems and on human health. These concerns need to be addressed through combinations of crop varieties, reclamation measures and cultivation practices, enabled by emerging technologies and policy interventions.

Way forward

India has now several national priorities such as enhancing farmers income (200%), reducing fertilizer use (25%) and water use (20%), increasing renewable energy use (50%), reducing GHG emission intensity (45%) and rehabilitating degraded land (26 Mha) to achieve. At the same time, being a signatory and prominent and responsible member of the United Nations and other global organizations, it has several international

commitments to fulfil such as Panchamrit and C neutrality (UNFCCC), land degradation neutrality (UNCCD), biodiversity conservation (UNCBD), regional agricultural development (SAARC) and Sustainable Development Goals (UN). The way forward for Indian agriculture, therefore, should focus on precision agriculture, reducing chemical footprints, nature-friendly farming; use of nano-fertilizers, with more synergy in crop, weather and water cycles and crop planning using ecosystem approaches. Fortunately, along with challenges, the developments in science are creating new avenues for tackling the challenges and fulfilling the priorities and commitments. For timely monitoring of weather, plant and soil indicators and provide artificial intelligence-based advisory to farmers, ICAR initiated a network programme on precision agriculture. Research on agricultural genomics would be one of the core research activities, which has made substantial progress in the past.

The ICAR and the NARES at large, are determined to harness the advances of science for the welfare of society. The Council is committed to transform itself into an organization engaged fully with the farmers, industry, entrepreneurs and consumers. A multi-pronged strategy with integration, diversification, clustering, customised farm mechanisation, value addition and market access is required to realise the full potentials of farming. Developing varieties tolerant to multiple abiotic and biotic stresses using stress-tolerant QTLs, genes and alleles in elite cultivars is an efficient way of achieving higher yields and sustainability. Methods and tools for conserving, storing and enhancing water use efficiency through pressurized, low cost and demand-driven micro-irrigation systems need to be upscaled to horticultural and field crops. Application of neem-coated urea well calibrated according to soil health card and leaf colour charts should become common practices for enhancing fertilizer use efficiency. Microbe-based technologies for nitrogen fixation, nutrient recycling, bio-residue management and alleviation of abiotic and biotic stresses have also been found useful. The conservation agriculture, beyond the irrigated ecosystem, should prolifically be used to reduce the carbon foot-print of production systems. Development and deployment of smart small machines using renewable energy sources and solar-powered water pumps, sprayers and weeders should get more momentum. Greater thrust is needed with regard to agri-infrastructure both during the production and post-harvest phases, the latter in terms of processing and storage facilities. The focus should be on export orientation, ecosystem approach, sustainable food system, smart farming, post-harvest value addition and entrepreneurship engaging youth and women. A two-way digital communication between the farmers and scientists should be the new paradigm of technology delivery system.

Conclusion

Ensuring food and nutritional security, improving rural livelihood along with environmental security in a sustainable manner, will remain the major goal of the agricultural development planning. India will strive to help achieve these goals through development of improved agricultural technologies along with their efficient and effective modes of dissemination. It is estimated that the annual growth in the productivity of food grains should be more than 1.5% and that of horticultural crops more than 3% to meet this goal. This will essentially require development of improved varieties of field and horticultural crops with desirable traits under the changing environmental scenario. At the same time, technology will also be needed to increase the input use efficiency to reduce the cost of production and enhanced value addition to make Indian agriculture profitable, competitive and attractive to rural youth. In addition, value addition through processing will help in reducing

colossal losses on one hand and increase the income of the farmers on the other. ICAR is ready to take up the challenges with focused research programs keeping in mind the recent developments in science and technology, changed economic environment and opportunities at national and international arenas for higher productivity, profitability, sustainability and climate resilience to meet the aspirations of Indian agriculture.

References

ICAR (1988) 40 Years of Agricultural Research and Education in India. Indian Council of Agricultural Research, New Delhi.

ICAR (2021) DARE-ICAR significant achievements (2014-2021). Indian Council of Agricultural Research, Krishi Bhawan, New Delhi, p. 64.

IGI (1907) Imperial Gazetteer of India, The Indian Empire, Economic, Published under the authority of His Majesty's Secretary of State for India in Council, Oxford at the Clarendon Press. Chapter X: Famine, pp. 475–502.

Mohapatra T and Raut PK (2021) Indian Agriculture - a journey from begging bowl to sustainable food security. Science Reporter 58:63-69.

Pathak H (2015) Greenhouse gas emission from Indian agriculture: Trends, drivers and mitigation strategies. Proc Indian Natl Sci Acad 81(5): 1133-1149.

Pathak H and Ayyappan S (2020) Sustainable agriculture in a changing world. Curr Sci 119 (11):1731-1732.

Randhawa MS (1980-88) History of Indian Agriculture (4 volumes), Indian Council of Agricultural Research, New Delhi.

Singh RB (2014) Transforming Agricultural Education for Reshaping India's Future. National Academy of Agricultural Sciences, New Delhi.

Singh RB (2016) 100 Years of Agricultural Sciences in India. National Academy of Agricultural Sciences, New Delhi, pp 538.

Yadav OP, Singh DV, Dhillon BS and Mohapatra T (2019) India's evergreen revolution in cereals. Curr Sci 116 (11):1805-1808.

Ramesh Chand(2021): Agriculture in post Independence India :Looking back and looking ahead. ICAR Lecture Series #29.