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The Indian Agricultural Scenario

Introduction

The agriculture sector is and will remain central to India's economic development for the foreseeable future. Being the largest private enterprise (sustaining around 138 million farm families), it contributes around 17.4% of gross domestic product (GDP) and engages around 55% of the workforce (MoA and FW, 2015). Hence, advancement in agriculture and the allied sectors is a necessary condition for inclusive economic growth at the national level. The role of the agricultural sector in alleviating poverty and ensuring household food and nutrition security is very well established.

Indian agricultural systems are predominantly mixed crop-livestock farming systems; the livestock segment supplements farm income (30–40%) by providing employment, draught animals, milk, manure etc. Over the years, agriculture has become increasingly knowledge-intensive and market-driven. Accordingly, far more innovative research, enabling policies, and effective delivery of services, supplies and markets are prerequisites for accelerating agricultural growth. Since science and technology are the key drivers of change, agricultural growth has to be knowledge-technology- and resource-driven.

The total geographical area of the country is 328.7 million ha, as per the land-use statistics of 2013–14, of which about 141 million ha were reported to be net sown area, and 201 million ha were gross cropped area with a cropping intensity of 142%. At present, the net irrigated area is 68.2 million ha (MoA and FW, 2015–16). A continuous decline in the share of agriculture and the allied sectors in the gross value added (GVA) has been noticed, from 18.2% in 2012–13 to 17% in 2015–16, at current prices. This is an expected outcome in a fast-growing and structurally changing economy, but its importance remains critical because of the contributions to rural livelihood, poverty reduction and food security. According to the World Trade Organization (WTO), the share of India's agricultural exports and imports in world trade in 2013 and 2014 was 2.69% and 1.31%, respectively. Agricultural exports as a percentage of the agricultural GDP increased from 9.1% in 2008–09 to 14.05% in 2013–14 (Arjun, 2013; Goyal and Shrama, 2013; MoA and FW, 2015).

Since the beginning of the economic reforms in 1991, growth in agricultural GDP showed high volatility. It fluctuated from 4.8% per annum in the eighth Five Year Plan (1992–96) to a low of 2.4% during the 10th plan (2002–06), but rose again to 4.1% in the 11th plan (2007–12) (Fig. 1.1). Recent estimates, corresponding to the 12th plan, show a decline, reporting a growth of 2.2% (MoA and FW, 2015–16). The share and growth of agriculture and the allied sectors at the state level present a very different scenario from that at the national level. While at the national level, the agricultural and allied sectors

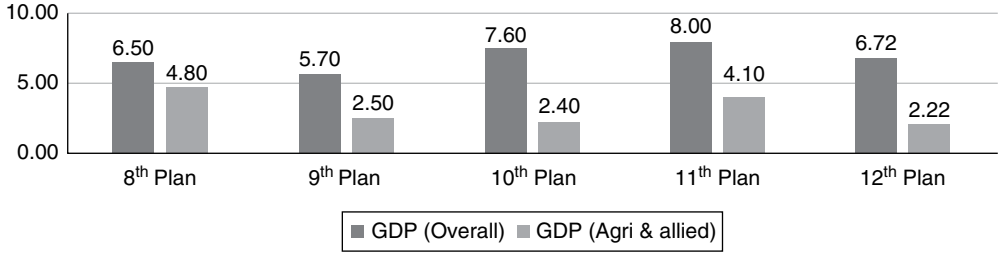

Fig. 1.1. Agricultural growth rate (%) during different plan periods. (Central Statistical Office figures for the 12th five-year plan, calculated using GVA at basic 2011–12 prices)

contributed about 14% to GDP in 2013–14 (at 2004/2005 prices), a number of states showed a much larger share of agriculture in the gross state domestic product (GSDP). In 13 states, the share of agriculture in their GSDP was around 20%, whereas in seven states the contribution of agriculture was less than 15% (GoI, 2007–12; MoF, 2015–16).

Productivity Convergence

Agricultural performance was mixed across states during the past. Some states performed well while others lagged behind. Despite that, low-productivity states performed well and were found to be converging with their high-productivity counterparts. For instance, during the past two decades since the 1990s, land productivity growth was the highest in Bihar (5.92%), followed by Maharashtra (4.34%) and Madhya Pradesh (4.13%), essentially low-productivity states. The states where the initial land productivity level was relatively high grew by less than 2%. This increased vigour of the low-productivity states can be attributed to higher returns on investments made, while the opposite was true for high-productivity states. Targeting further public investment in these states and raising productivity potential in the high-productivity states would help to sustain growth in the future (NAAS, 2009).

Diversification

For overall growth in income and demand, the farm sector has diversified its production patterns towards commercial and horticultural crops and also livestock products. In fact, the positive growth in agriculture observed in the post-economic reform period can, in part, be attributed to the performance of the allied agriculture sectors and to fruits and vegetables. By 2011, the value of the output of fruits and vegetables equalled that of cereals, and the output value of the livestock sector equalled the total value of foodgrains and oilseeds. Between 2001 and 2011, output share from the allied sector increased by more than 10% in Bihar and Tamil Nadu. In Andhra Pradesh and Uttar Pradesh, it was between 5% and 10%. In Gujarat and Maharashtra, output was raised through cash crops. Incremental output shares obtained between 2001 and 2011 through cotton and sugarcane were more than 10% in Gujarat and 7% in Maharashtra. It was noticed that the states that diversified more achieved better outputs, and hence converged. Expecting that income and demand growth would continue, at least in the near future, augmenting diversification with region-specific planning and linking products efficiently to markets would boost the sector's performance (Goyal and Shrama, 2013).

Land Holdings

The Department of Agriculture and Cooperation of the Ministry of Agriculture and Farmers' Welfare, Government of India, conducted the first-ever agriculture census, referencing 1970–71. Since then, eight censuses have been conducted. The current agriculture census, referencing 2010–11, is the ninth census. For the collection of census information, an 'agricultural holding' is defined as the economic unit of agricultural production

under single management comprising all livestock kept and all land used wholly or partly for the purpose of agricultural production, regardless of its title, legal form and size. The census revealed that the total number of operational holdings in the country were 138 million in 2010–11, with a total area of 159.6 million ha, with an average size decline of 1.15 ha (from 1.23 ha in 2005–06) and with increasing fragmentation (Table 1.1). This led to smaller sizes of land holdings and more clusters per holding. The percentage share of female operational holders was only 12.79%. Small and marginal holdings taken together (below 2 ha) constitute 84.97% of the total holdings (70% in 1953–54), forming 44.31% of the total operated area. Semi-medium and medium operational holdings (2–10 ha) constitute 14.3% of the total holdings with 44.77% of the total operated area; whereas the large holdings (10 ha and above) constitute 0.73% of the total number of holdings, with a share of 10.92% in the total operated area. Thus it can be seen that 85% of the farmers cultivate about 44% of the operated area, and 15% of the farmers cultivate 56%. Although small and marginal farmers are found to have higher productivity compared to large holdings, they invariably have a low marketable surplus and profit. There has been significant fragmentation of operational holdings in India. Medium holdings are getting reduced to small and marginal holdings with no sign of a reversal in the foreseeable future (NAAS, 2009; MoA and FW, 2010–11).

This trend obviously makes a strong case for much-needed land reforms, especially for land consolidation, as well as reforms in tenancy laws. Consolidation of land holdings in Punjab, Haryana and Uttar Pradesh has helped in accelerating agricultural growth. In India, the contribution of small farmers to total farm output exceeded 50%, although they cultivated only 44% of the land. Small farmers are characterized by smaller applications of capital but higher use of labour and other family-owned inputs, and a generally higher index of cropping intensity and agricultural diversification. To ensure livelihood security of the marginal and smallholder farmers, it is necessary to focus on their technological needs as well as infrastructure, including new avenues for gainful employment in the non-farm sector. With current trends, the projections are that small and marginal farmers may account for more than 90% of farm holdings by 2030.

Natural Resource Management

Natural resources, both physical and biological, form the primary production base of agriculture. Unfortunately, they are facing rapid degradation, be it soil, water, biodiversity or environment. The challenge of natural resource management is evident from the fact that with a mere 2.4% share of the world's land and only a 4% share of the world's freshwater resources, the agriculture sector of India has to cater to 17.5% of the world's population (MoA and FW, 2015). The net area sown has remained stagnant at around 140 m/ha with a variation of ±2 m/ha in some years for more than five decades, and in view of the competing demands for land by other sectors it is not likely to increase further. The total area in the country affected by different forms of land degradation (water erosion 82.57 million ha; wind erosion 12.4 million ha; chemical degradation 24.68 million ha; physical degradation 1.07 million ha) is estimated at approximately 121 million ha, of which 105 million ha are arable land and 16.53 million are open forest. Based on digitized maps with a scale of 1:250,000, the total salt-affected area in the country is estimated at 6.73 million ha. As per recent projections, about 15.5 million ha is likely to be affected by 2030 owing to waterlogging and soil salinity in irrigation commands. To restore and maintain such land will be a challenge, and hence immediate and long-term ameliorative measures are required.

Water

Water is the most important resource for agriculture, gaining primacy even over soil. Out of the total annual precipitation of 4000 billion m^3 (bcm), the utilizable water resources of the country have been assessed as 1123 bcm, of which 690 bcm are from surface water and 433 bcm are from groundwater sources. It has been projected that population and income growth will boost water demand further in the future in order to meet food production, and domestic and

Table 1.1. Number and area of operational holdings by size group and area operated. The numbers in brackets indicate percentage share out of total holdings. (From: MoA and FW, 2015)

	Number of holdings ('000)			Area ('000 ha)			Average size of holding (ha)		
Category of holdings	2000–01*	2005–06*	2010–11	2000–01*	2005–06*	2010–11	2001–01*	2005–06*	2010–11 (P)
Marginal	75,408	83,694	92,356	29,814	32,026	35,410	0.40	0.38	0.38
(less than 1 ha)	(62.3)	(64.8)	(67.0)	(18.7)	(20.2)	(22.2)			
Small	22,695	23,930	24,705	32,139	33,101	35,136	1.42	1.38	1.42
(1–2 ha)	(19.0)	(18.5)	(17.9)	(20.2)	(20.9)	(22.1)			
Semi-medium	14,021	14,127	13,840	38,193	37,898	37,547	2.72	2.68	2.71
(2–4 ha)	(11.8)	(10.9)	(10.1)	(24.0)	(23.9)	(23.6)			
Medium	6577	6375	5856	38,217	36,583	33,709	5.81	5.74	5.76
(4–10 ha)	(5.5)	(4.5)	(4.3)	(24.0)	(23.1)	(21.2)			
Large	(1.0)	(0.8)	(0.7)	(13.2)	(11.8)	(10.9)			
(10 ha and above)									
All holdings	**119,931**	**129,222**	**137,757**	**159,436**	**158,323**	**159,180**	**1.33**	**1.23**	**1.16**
	(100.0)	**(100.0)**	**(100.0)**	**(100.0)**	**(100.0)**	**(100.0)**			

*Excluding Jharkand

industrial requirements. The projected total water demand in 2050 is 1447 bcm of which 1074 bcm would be for agriculture alone. India has only 4% of the world's freshwater resources (MoA and FW, 2015–16).

It is quite encouraging that the country as a whole has about 88% ultimate irrigation potential (UIP) developed through different major, medium and minor irrigation schemes. Thus, there is very little scope for further large-scale expansion of irrigation infrastructure. Therefore, improving the efficiency of already-created irrigation infrastructure by removing existing operational and maintenance inefficiencies would contribute directly to future agricultural growth. Most of the irrigation projects are operating at an overall efficiency of only about 30– 35%, as against achievable efficiency of more than 50%. Presently, about 78 million ha are rainfed, and it is estimated that even with exploitation of all utilizable water resources, approximately 55% of the gross cropped area would remain rainfed. The rainfed production system accounts for 91% of the production of coarse cereals, 49% of rice, 91% of pulses, 80% of oilseeds and 65% of cotton, and the situation is likely to remain the same for the next 40 years (MoA and FW, 2015). Large tracts of land are dependent on seasonal rainfall for crop cultivation, which hampers productivity and the adoption of high-yielding varieties as well as other inputs. Yields in rainfed areas are quite low, which underscores the importance of irrigation. The state-wise coverage of irrigated areas with major crops in 2012–13 showed several states with less than a 50% irrigated area. Targeted efforts are required to expand irrigation in such states, where investment is likely to increase cropping intensity.

Only about 66 million ha (47.6%) of the net sown area is reported to be irrigated. There is obviously a need to bring more cropped areas under assured irrigation to increase agricultural productivity and production. The ultimate irrigation potential of the country is estimated at 140 million ha, with 76 million from surface water and about 64 million from groundwater. High priority needs to be given to harnessing irrigation potential. Drip and sprinkler systems are gaining popularity for high-value crops such as horticulture, plantations and sugarcane. It is estimated that about 50% of water conservation can be achieved through such systems. Policy has also been restructured to focus on increasing efficiency of water use through micro-irrigation, which includes drip and sprinkler systems. The government has a programme for subsidizing micro-irrigation, but it is usually linked with credit, and therefore access to financial institutions is a must in order for micro-irrigation to increase (NAAS, 2009).

Soil

Indian soils broadly fall into five main groups: red, black, alluvium-derived, soils of the arid regions, and soils of the Himalayan and Shiwalik regions. These differ in their productivity and need different management depending on their physical and chemical properties, the biological conditions, the rainfall/availability of water for irrigation, and crops and cropping systems. Partial-factor productivity of fertilizers is declining in intensive cropping systems, from 15 kg foodgrains/kg NPK in 1970 to 5 kg in 2005. The current status of nutrient use efficiency is quite low for P (15–20%), N (30–50%), S (8–12%), Zn (2–5%), Fe (1–2%) and Cu (1–2%). Recently, prepared geographic information systems (GIS)-based, district-wise soil fertility maps of India (Muralidharudu *et al.*, 2011) showed about 57% of districts with low available N, medium levels in 36% and high levels in 7%. Similarly, 51% of districts showed low P levels, 40% with medium levels and 9% with high levels. K was low in 9% of districts, medium in 42% and high in 49%. Soil organic matter plays a key role in soil fertility sustenance. Thus, assessment of soil organic carbon (SOC) accretion/sequestration under intensive cropping with different management practices would play an important role in the long-term maintenance of soil quality.

Biodiversity

Biodiversity is essential for food security and nutrition. Thousands of interconnected species make up a vital web of biodiversity within the ecosystems upon which global food production depends. With the erosion of biodiversity, humankind loses the potential to adapt ecosystems

to new challenges such as population growth and climate change. Achieving food security for all is intrinsically linked to the maintenance of biodiversity. Agrobiodiversity is a vital subset of biodiversity and is the result of both natural selection processes, careful selection and inventive developments by farmers, herders and fisherman over hundreds of years. The Food and Agriculture Organization of the United Nations (FAO) defines agrobiodiversity as:

> The variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fibre, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators), and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest and aquatic) as well as the diversity of the agro-ecosystems.
>
> (FAO, 1999)

With about 47,500 plant species, out of about 0.4 million that are known worldwide, India has more than 11% of the world's flora. About 28% of plants in India are endemic, making it one of the 17 mega-centres of diversity in the world, and recognized by the World Conservation Monitoring Centre in 2000. Floral diversity is mostly concentrated in four biodiversity hotspots: the eastern Himalayas, the western Ghats (and Sri Lanka), north-east India, and the Andaman Islands (Indo-Burma) and Nicobar Island (Sundaland). These represent some 12% of 34 biodiversity hotspots recognized in the world. Of the 990 known species of orchids, 700 are from the north-eastern region of India.

Appropriate policy frameworks are needed to achieve the desired objectives of conservation efforts. Recent times have witnessed efforts by international and national authorities to establish such frameworks. The Convention on Biological Diversity (CBD) is such an instrument, which not only addresses biodiversity but also protects the sovereign rights of nations and communities over this precious wealth. Some of the global efforts apart from CBD have been the Bonn guidelines on access to genetic resources for fair and equitable sharing (Secretariat of the Convention on Biological Diversity, 2002) and the World Intellectual Property Organization (WIPO) Track Treaties. Sharing out of benefits from resource utilization with native communities is an important aspect of all these guidelines and is likely to influence concerns of preserving resources at the grass-roots level. Although legally binding laws on benefit-sharing hardly exist, some countries like Guyana, Uganda, Brazil, Queensland, Ethiopia and India are in the process of preparing them.

India, being a signatory of the Biological Diversity Act 2002 and the rules of 2004 for judicious utilization, strives to conserve its biodiversity. To implement the various provisions of the Act, the National Biodiversity Authority and state biodiversity boards are already in place. Another important issue that the Act deals with is access of foreign nationals to Indian biodiversity.

Livestock

According to a recent report from the Department of Animal Husbandry, India ranks first in the world in buffalo population, second in cattle and goat, third in sheep, fourth in duck, fifth in chicken and sixth in camel. The total livestock population in India, consisting of cattle, buffalo, sheep, goats, pigs, horses, ponies, mules, donkeys, camels, mithun and yak is 512.05 million (2012 figures). The total livestock population has decreased by about 3.33% from the previous census. The census also points to an increase in the number of milch animals (in milk and dry), cows and buffalo, from 111.09 million to 118.59 million, an increase of 6.75%. The number of animals in milk (cows and buffalo) has increased from 77.04 million to 80.52 million, showing a growth of 4.51%. The total number of sheep in the country is 65.06 million (in 2012), a decline of 9.07% since the 2007 census. The goat population has declined by 3.82% and the total number of goats in the country is 135.17 million (in 2012) (DAH and DF, 2015–16; http://mospi.nic.in).

Fish

Of the 34,000 fish species reported globally (http://www.fishbase.org/search.php), over 3300

occur in the Indian subcontinent. The database of National Bureau of Fish Genetic Resources (NBFGR) has 868 indigenous species; of which 877 are found in freshwater, 113 in brackish water and 1878 in marine waters. They belong to 39 orders, 225 families and 852 genera. Biodiversity-rich areas such as north-east India and the western Ghats have been explored through many network programmes. The discovery of more than 40 new species in recent years indicates that there may be many more that are unknown, and thus there is the need for intensification of exploration activity, particularly in the deep seas of the exclusive economic zone (EEZ), in cold deserts, and in other upland regions and aquatic bodies in the western Ghats and north-east region. India's rich aquatic genetic diversity is a huge source of genes responsible for imparting unique physiological adaptations to organisms inhabiting different aquatic ecosystems, which are potential products with high commercial applications. This not only poses the challenge to harness the potential of vast available genetic resources but also in maintaining sovereign claims on the benefits.

Farm Energy and Mechanization

Farm energy and mechanization plays an important role in providing optimal utilization of resources and economy of time, and also in reducing drudgery. Judicious use of time, labour and resources facilitates sustainable intensification (multi-cropping) and timely planting of crops, leading to increased productivity. Many empirical studies have established a positive relationship between foodgrain productivity and availability and growth of farm power. However, increases in energy intensity of production systems and energy-based inputs raise the cost of cultivation. The consumption of electricity for agricultural purposes is given in Table 1.2. This intensity would increase further if the agro-processing sector is also considered.

Post-harvest Management

India produces, annually, over a billion tonnes of raw food crops and commodities, and some of these, mainly fruits, vegetables, milk, meat and fish, are highly perishable. For want of adequate cold-chain facilities, and processing and product development technologies, a considerable amount of produce is lost. The country can ill afford this loss. On average, post-harvest losses of 4–6% in durables and 12–15% in fruits and vegetables were documented. The challenge is to handle fresh produce post-harvest with reduced losses, value addition and maintenance of eating quality. Agro-processing is now regarded as the sunrise sector of the Indian economy, in view of its large potential for growth and likely socioeconomic impact, specifically on employment and income generation. Some estimates suggest that in developed countries, up to 14% of the total workforce is engaged in the agro-processing sector, directly or indirectly. In India, however, only 3% of the workforce finds employment in this sector, indicating its underdeveloped state and vast untapped potential for employment. When properly developed, the agro-processing sector would make India a major player globally in the marketing and supply of processed food, feed and a wide range of other plant and animal products. Farmers' skills need to be developed to undertake some

Table 1.2. Consumption of electricity for agricultural purposes. (Central Electricity Authority, Delhi)

Year	Consumption for agricultural purposes (GWh)	Total consumption (GWh)	% share of agricultural consumption to total consumption
1982–83	17,817	95,589	18.64
1985–86	23,422	122,999	19.04
1990–91	50,321	190,357	26.44
2000–01	84,729	316,600	26.76
2009–10	119,492	569,618	20.98
2010–11	126,377	616,969	20.48
2011–12	140,960	672,933	20.95
2012–13	147,462	708,843	20.80

primary processing or small-product development, while the industrial sector needs to look at the large-scale production of value-added products with enhanced shelf lives.

Education

Beginning with only 17 agricultural colleges, one agricultural engineering college and three veterinary colleges in the 1950s, the agricultural education system has made remarkable progress. Currently, there are 67 state agricultural universities (SAUs), four deemed-to-be universities (DUs), three central agricultural universities (CAUs) and four central universities (CUs). After independence, the country supported the development of a comprehensive agricultural education system. Agricultural education in India follows the land grant college model of the USA. In this model, teaching, research and extension are integrated into a single institution.

Even though higher agricultural education is included in the list of state subjects, the Indian Council of Agricultural Research (ICAR) provides financial support to SAUs and other public sector institutions in the form of development grants and merit scholarships/fellowships. The development grant extended by the ICAR specifically enables (i) maintenance of quality of teaching facilities, learning materials and environment; (ii) conducting postgraduate research; (iii) building limited faculty competence; and (iv) ensuring timeliness in admissions and conduct of practical training, whether in a laboratory or the field. Triggered primarily by professional and academic links with SAUs, the ICAR has been able to foster a country-wide system of producing technically qualified human resources through education and training. It is the human resources developed by the agricultural education system that have been instrumental in the transformation of agriculture.

The existing education system is sufficient to ensure a supply of technically qualified manpower to maintain the science- and technology-driven growth of agriculture. However, it is not adequate to generate human resources that can measure up to the emerging challenges and scenarios in agriculture. Guided largely by internal and external pressures, the need for new knowledge and skills is becoming more challenging than ever. The agricultural education system needs to keep pace with rapid technological, economic and social developments taking place nationally and globally. Falling productivity, increased natural resource degradation, rising unemployment and varied market forces due to the phenomenon of globalization and the opening up of world economies necessitate that in future agricultural graduates should not be mere degree holders; instead they must be professionals who can envision and interpret problems and devise solutions. In so doing, they may become entrepreneurs and job creators.

Extension

Frontline demonstrations and other extension services show a large gap between what can be achieved with available improved technologies and practices and what can be realized by e-farmers. The Royal Commission on Agriculture in India report 1928 mentions that: 'In order that agricultural research may be of use to the cultivator, its results must be given to him in a form in which they may become a part of his ordinary practice.' Further, about the technology being provided to the farmer, the report observes that:

> . . .before an improvement can be recommended for general adoption, it must be thoroughly tested on a government farm. It must be within the means of the cultivator to whom it is recommended and it must give a substantial financial advantage either in increased outturn or in the reduction of his cultivation expenses.

There is a growing perception that emerging concerns of farmers about recent technological and institutional needs are not being addressed adequately. Also, research systems are not getting adequate feedback in order to plan and conduct demand-driven research. As a result, there is a need for quality research at the farm level. It is also perceived that research systems should play a proactive role in reaching farmers to hear their perceptions of and feedback on technologies in order to develop appropriate processes, methodologies and technology for diverse farming practices.

Dissemination of agricultural technologies by the National Agricultural Research System (NARS) is in the form of frontline demonstrations through 700 Krishi Vigyan Kendras, spread throughout the country. In the last two to three decades, a phenomenal growth and spread of information technology has occurred, and India is now among the leading nations in the use of IT applications. The agriculture sector has immense potential to benefit from IT advances, from weather parameters, advice on crop cultivation and animal care, markets, government policies, domestic and global demand for a particular food item etc., and this can go a long way to improve returns on investment made by farmers.

Public Investment in Agriculture

The preference for investment over subsidies was agreed upon, yet the rate at which investment has been made by the public sector has raised concerns. A decline in public investment came in the wake of the deceleration in agriculture, as well as other factors. Despite low investment signals, the Central Statistics Office (CSO) estimates showed that the share of public investment in agriculture was 0.5% of the national GDP in 2010–11 and the rest (2.1%) was from the private sector, raising total investment to 2.6% of GDP. The investment allocation to agriculture in the 12th plan, 4.7% of total investment, was a patent neglect of agriculture. The real investment trend followed no definite path. During 2013, Haryana attracted the highest capital expenditure, around Rs 7 billion, followed by Uttar Pradesh (Rs 6.22 billion) and Maharashtra (Rs 5.95 billion). The level of expenditure increased in most states. In Madhya Pradesh and West Bengal, real capital expenditure on agriculture and its allied sectors increased more than four times between 2001 and 2013. In Karnataka, Tamil Nadu, Himachal Pradesh, Rajasthan and Bihar, the increase was between two and three times during the period. However, in Punjab, Assam, Andhra Pradesh and Odisha, investment slowed down dramatically. Establishing return-based investment decisions across states would greatly escalate performance. One notable feature of these investments was that despite interstate differences in public investment, there was no underinvestment in the states with dry-land agriculture or other marginal production environments. This may have resulted in greater convergence of land productivity.

Sustained public funding has been the main policy instrument of agricultural research and development (R&D) in the country, which was useful in creating scientific infrastructure and human capital. This policy paid rich dividends in terms of economic and other impacts of agricultural research. The Economic Survey of 2014–15 also mentioned that 'agriculture and food sectors need huge investment in research, education, extension, irrigation, fertilizers, and laboratories to test soil, water, and commodities, and warehousing and cold storage'. The present research intensity (0.4% of AgGDP) is much lower than that of other developing countries, and should be raised immediately to 1% of AgGDP and gradually to 2% thereafter. Extension intensity is also low, nearly half of research intensity. A welcome feature of public investment in agricultural research is that, excepting a few states like Uttar Pradesh, the research portfolio is quite balanced in terms of regional, commodity and thematic priorities. To address R&D needs, which are growing exponentially, increased resources are essential to revitalize NARS in general and SAUs in particular. Greater efforts are needed in post-harvest management and value addition, in the context of emphasis on secondary agriculture. Attaining global competitiveness, excellence in upstream research and production of first-rate human resources require adequate and competent scientific manpower. Higher investments in agricultural R&D as well as human resource development (HRD) are envisaged in the best interests of faster growth and the development of India.

The Role of Markets

The performance of Indian agriculture is directly linked to the access of farmers to input and output markets. There has been considerable progress in this direction, but agricultural markets need to be modernized for inclusiveness and efficiency. The system of agricultural marketing should be strengthened and integrated to meet

rising demands of consumers on the one hand and, on the other, farmers should be able to realize higher prices. Recent reforms such as the Agricultural Produce Marketing Committee (APMC) Act, contract farming and eNAM can be cited as measures to improve market integration, infrastructure and technology use. However, states' participation and compliance is highly erratic. Even existing market establishments prove to be inadequate, thus hampering access to market. Against the recommendation of a regulated market in each 80 sq. km, the present scenario throws out a picture of an average coverage of 490 sq. km/market. The country has just one sixth of the recommended strength. Furthermore, farmers' awareness of price support measures does not seem encouraging. The situation assessment survey of the National Sample Survey Office (NSSO) points out that just 30% and 40% of farmers reporting the sale of paddy and wheat, respectively, are aware of the existence of the minimum support price (MSP) instrument. Awareness about procurement agencies is still less convincing. Improving market access through new establishments, infrastructure and technology upgrades, participation, compliance and transparency are all immediate measures that are needed in the agricultural marketing sector. There are some parts of the country, like eastern India, where much investment is needed in rural infrastructure along with greater emphasis on agricultural markets.

Non-farm Employment

Cultivation remains the major source of income in rural India, yet rural households are increasingly participating in non-farm activities. In recent times, the non-farm employment sector has proved to be an engine for rural growth and increased income per household. The share of non-farm employment was one sixth (16.6%) of total rural employment at the end of the 1970s. This increased to one fifth (21.7%) within a decade, and the sector employed more than one third of the total rural workforce (35.9%) in 2011–12. Manufacturing, construction, trade and hotels and restaurants are the usual areas where rural households are engaged; and higher wages in these sectors continue to attract labour. Employment levels were relatively high in Kerala, West Bengal and Tamil Nadu since the employment levels almost doubled between 1983 and 2001 and the share stood, during 2011/12, at 68.6%, 46.8% and 48.8%, respectively. The sector has expanded in the remaining states as well. Between 1983 and 2011/2012, employment almost tripled in Rajasthan (2.9 times) and Himachal Pradesh (2.85 times), and more than doubled in Punjab (2.68), Madhya Pradesh (2.53), Jammu and Kashmir (2.42), Uttar Pradesh (2.15), Chhattisgarh (2.13), Jharkhand (2.12), Bihar (2.08) and Uttarakhand (2.01). Except in Jammu and Kashmir, the employment share in the rest of these states was less than 20% in 1983.

Lately, a striking feature observed among rural farm households in India has been a 'hybrid' kind of income dependence; not only are labour households shifting their priorities to an 'off-the-farm' mode by sharing labour services, but cultivators also are participating in a 'part-time farming' approach. Continuous non-farm expansion, fostering household income, and the macro-economic implications of a shift in labour, especially in farm households, require immediate attention. This shift of labour is expected during a process of economic development, but the impact on agriculture is in the form of higher wages, which have showed high growth in the recent past. Therefore, farm mechanization to reduce costs and improve the efficiency of farm operations is necessary to achieve a structural shift in the rural workforce.

Indian agriculture is on a path of high growth and structural transformation that needs to be sustained. Higher investment, improved markets and flow of technology are necessary to sustain this growth. Since all these developments need more capital, both from the public and private sectors, access to financial institutions and enhanced allocation of public funds are musts. There is a need for more focus on rural infrastructure, health and education, and developments in these areas would enhance rural connectivity, inclusiveness and better human capital, which will help to sustain agricultural growth.

References

Arjun, K.M. (2013) Indian agriculture – status, importance and role in the Indian economy. *International Journal of Agriculture and Food Science Technology* 4(4), 343–346.

DAH and DF (2015–16) *Annual Report 2015–16*. Department of Animal Husbandry, Dairy and Fisheries, Ministry of Agriculture and Farmers' Welfare, Government of India, New Delhi.

FAO (1999) Agricultural Biodiversity, Multifunctional Character of Agriculture and Land Conference, Background Paper 1. Maastricht, Netherlands.

GoI (2007–12) *Eleventh Five Year Plan (2007–12)*. *Agriculture, Rural Development, Industry, Services and Physical Infrastructure, Vol. III*. Government of India, New Delhi.

Goyal, M. and Shrama, A. (2013) Changing face of Indian agriculture in global scenario. *International Journal of Agricultural Science and Research* 3(1), 217–224.

MoA and FW (2010–11) Agriculture Census 2010–11 (Phase-I). *All India Report on Number and Area of Operational Holdings (Provisional)*. Agriculture Census Division, Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture and Farmers' Welfare, Government of India, New Delhi.

MoA and FW (2015) *Agricultural Statistics at a Glance 2015*. Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture and Farmers' Welfare, Government of India, New Delhi.

MoA and FW (2015–16) *State of Indian Agriculture 2015–16*. Directorate of Economics and Statistics (Pocket), Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture and Farmers' Welfare, Government of India, New Delhi.

MoF (2015–16) *Economic Survey 2015–16*. Ministry of Finance, Government of India, New Delhi.

Muralidharudu, Y., Reddy, K., Mandal, S., Rao, B.N., Subba, A., Singh, K.N. and Sonekar, S. (2011) *GIS Based Soil Fertility Maps of Different States of India*. AICRP-STCR, IISS, Bhopal, India.

NAAS (2009) *State of Indian Agriculture*. National Academy of Agricultural Sciences, NASC Complex, Pusa, New Delhi.

Secretariat of the Convention on Biological Diversity (2002) Bonn Guidelines. CBD, UNEP. Available at: https://www.cbd.int/doc/publications/cbd-bonn-gdls-en.pdf (accessed 21 August 2018).