ABSTRACT

Agriculture is a very important sector in Indian economy not only because of its contribution to GDP, or because it engages more than fifty per cent of the Indian workforce, but due to the fact that an average Indian household spends almost half of its expenditure on food. And to that extent, the larger goals of food and nutritional security, poverty alleviation, and other human development goals are closely linked with the performance of agriculture sector. The past two decades witnessed unprecedented changes in Indian economy. With the initiation of economic reforms in early nineties the overall economy witnessed a higher growth rate. At the same time however, growth rate in agriculture was lower than projected, resulting in the present agrarian crisis and causing large scale farmer suicides.

The post-Green Revolution phase was characterized by high input-use and decelerating total factor productivity growth (TFPG). The sustainability issue of crop productivity also emerged in this period. In recent years, agriculture experienced diminishing returns to input-use and a significant proportion of the gross cropped area faced stagnation or negative growth in Total Factor Productivity (TFP). Productivity attained during the 1980s could however not be sustained during the 1990s. Moreover many irrigation project areas problems of waterlogging and soil salinity arose due to over-irrigation and deep percolation and seepage losses in the absence of a suitable drainage system. Due to the degradation problems, growth in TFP could not make headway across most parts of the country. Thus, sustainable agricultural practices should balance environmental health and economic profitability in order to promote social and economic equity.

The present study observed that Total Factor Productivity (used as a proxy for sustainability), experienced considerable variations across crops and regions. Stagnancy was visible in traditional areas where intensive input use was aggravating the problems leading to unsustainable use of inputs. Within the Indian grains segment, performance of Maize was dramatic. It emerged as the third major food grain crop and the most important coarse cereal. Among commercial crops cotton experienced considerable improvement as a result of technological intervention. Other commercial crops especially sugarcane however, had a disappointing performance. Although the better off agricultural states were facing stagnant growth
however the less benefited states during the earlier phases of green revolution experienced higher TFP due to adoption of modern techniques of production. The study found that technological breakthrough and efficient use of available means is necessary for sustainability of Indian agriculture.

This study observed that although poverty had decreased, the extent of decline in the post-reform period in poverty was not higher compared to the pre reform period. The distribution of poverty was highly uneven in India, with some states having more than 40 per cent of the people living below poverty line. Similarly poverty was more common among few social groups especially SC/ST and Muslims. Among the occupational groups, incidence of poverty was highest among wage earning class. The study found an inverse or negative relationship between agricultural productivity and poverty reduction, implying that an increase in productivity would result in reduction of poverty. The magnitude of poverty reduction was however found higher in rain fed regions of the country.

Chapter 1 gives an introduction about the role of agriculture in economic development and poverty reduction. Various issues facing Indian agriculture are discussed. The chapter also includes a comprehensive review of available literature. It also includes the questions raised, objectives of the study and data sources used.

Chapter 2 gives the conceptual background of sustainability and the methods used in measuring sustainability. This chapter also deals with the methodology used in the present study. In order to study the year-wise growth in the variables, percentage growth rates and compound annual growth rates (CAGR) were calculated. Coefficient of Variation was also used. The present study is based on Non-parametric approach and uses Malmquist productivity index for measuring the TFP of Indian agriculture in order to establish the sustainability of agriculture. For measuring the relationship between agricultural productivity and poverty reduction ordinary least squares (OLS) regression model was used.

Chapter 3 gives an overall review of the Indian agriculture with an emphasis on the post reform time period. The most important feature of this period was that agricultural growth decelerated sharply at all India level and in all regions. The main reason for the deceleration of growth during the post reform period was a visible deceleration in investment in irrigation and other rural infrastructure. The Eleventh
Five Year Plan had sought to reverse the deceleration of agricultural growth which occurred in the Ninth Plan and continued into the Tenth Plan. It had some success as food grain production touched a new peak of 250.42 million tonnes in 2011-12 and average annual growth rate during the Eleventh Plan was 3.3 per cent which was much better than last two plans though less than targeted 4 per cent growth rate.

There was an increase in area under cultivation of wheat, while area under paddy cultivation decreased slightly. But in terms of production and yield both the crops had a disappointing performance indicating clearly that yield levels had plateaued for these crops and there was need for renewed research to boost production and productivity. Area under coarse cereals displayed a negative growth which was due to either shift to other crops or the relatively dry areas being left fallow. But production and yield of coarse cereals improved significantly especially during the decade of 2000-01 to 2009-10. This increase was primarily driven by rise in production and yield of maize and Bajra. Gram and Tur were the major contributors to total production of pulses in the country. The growth in indices of area and production was mainly on account of Gram, it recorded an impressive growth in its production. The oilseeds showed an improvement both in terms of yield as well in the area under cultivation. Apart from oilseeds cotton showed the biggest increase in the growth rates of production and yield during the last decade. Cotton experienced significant changes with the introduction of Bt. cotton. Since early 1990’s commercialisation of agricultural production seemed to gain momentum. There was a definite shift from food grains to non-food grains such as fruits and vegetables, oilseeds, fibres and condiments and spices whose share in both area and in value of output increased over the period. Although the shift from coarse cereals to high value crops increased farm output and incomes to farmers, in dry land regions it exposed cultivators to serious weather-borne risks due to high water requirement of high value crops.

There was a continuous decline in the share of Gross Capital Formation (GCF) of agriculture and allied sectors in total GCF; from 18 to 20 per cent in 1980s it declined to 5 to 6 per cent in 2007-08. Moreover, there was a significant decline in the allocation of public outlay on agriculture as a per cent of total public outlay during the post-reform period compared to that in pre-reform period. Most of the major river systems were fully exploited, moreover the massive expansion of tube well irrigation
led to serious overdrawing of groundwater and falling water tables. More than a fifth of groundwater aquifers were overexploited in Punjab, Haryana, Rajasthan, and Tamil Nadu, and groundwater levels have been falling. Almost 60 per cent of the dams in the country were more than two decades old. Canal networks also needed annual maintenance.

Although the all-India average consumption of fertilizers increased substantially to 144 kg per ha in 2011-12, the average intensity of fertilizer use in India remained much lower than most countries in the world. Further the use of fertilizer was highly skewed with wide inter-regional, inter-state and inter-district variations. One of the major constraints to fertilizer use efficiency in India was imbalance of applied nutrients. Nitrogen (N) applications tended to be too high in relation to the amount of potassium (K) and phosphate (P) used. This was partly the result of a difference in price of different nutrients, and partly due to the lack of knowledge among farmers about the need for balanced fertilizer applications.

Despite significant improvement in the spread, network and outreach of rural financial institutions, the quantum of flow of financial resources to agriculture continued to be inadequate. Agricultural credit was an important contributor to increased agricultural production; but only if it reached the farmers, especially, the disadvantaged groups, and if they were able to absorb it effectively. The share of marginal and small farmers in total credit had however fallen. It appeared that the banking system was still hesitant to provide credit to small and marginal farmers. Finally, an assessment of agriculture credit situation brought out the fact that the credit delivery to agriculture sector continued to be inadequate.

Chapter four deals with issues and challenges facing Indian agriculture which make agriculture unsustainable. It was found that India, like most developing countries, was characterised by excessive dependence of population on agriculture and low productivity in agriculture. Although the share of agriculture in GDP declined, the process of labour force shift had been slow; this made agriculture less productive sector in comparison to industry and services. The increasing burden of labour force on a slowly contracting cultivable land area leads to increasing number of holdings with lower size. This resulted in a sharp decline in average size of holding and growing marginalisation. This poses a challenge in terms of adoption of farm mechanization as well as generating productive income from farm operation.
Increasing incidence of farmer suicides was a strong manifestation of the fact that Indian agriculture and farming community was in a very deep crisis. During the period between 1997 and 2010 as many as 232464 farmers committed suicide in India. Indebtedness was one of the major factors responsible for agrarian crises and resulting farmer suicides. As many as 48.6 per cent of farmer households in India were indebted and indebtedness of farmers was predominantly tied to informal sources of credit and not to institutional credit structures like banks and co-operative credit societies.

Despite a promising beginning, the further intensification of input use since the adoption of Green Revolution technologies in the mid-1960s, provided lower marginal returns and the continued intensification of cropping sometimes caused degradation of the resource base in the form of salinization, overexploitation of ground water, physical and chemical deterioration of the soil, and pest and disease problems. The broader worries about the environmental sustainability of the current agricultural practices include: excessive and inappropriate use of fertilizers and pesticides that pollute waterways and kill beneficial insects and other wildlife; irrigation practices that lead to salt build up and eventual abandonment of some of the best farming lands; increasing water scarcities in major river basins; and retreating groundwater levels in areas where more water was being pumped for irrigation than can be replenished. Degradation of soil one of the biggest challenges, was evident in increased soil erosion, decline in soil fertility, water-logging, secondary salinization and contaminations of soils with toxic elements. Land available for cultivation declined over time while land not available for cultivation increased continuously. The quality of Indian soils gradually deteriorated at the farm and eco-system levels. The major threats to soil quality came from a loss of organic carbon, erosion, nutrient imbalance, compaction, salinization, water-logging, decline in soil bio-diversity, urbanization, contamination with heavy metals and pesticides and from an adverse impact of climate change.

Massive expansion of irrigation infrastructure after independence transformed agriculture production in the country. But most of the potential created during these years was proving to be insufficient. Most of the major river systems were fully exploited at least part of the year, and the massive expansion of tube well irrigation led to serious overdrawling of groundwater and falling water tables. The problem was
more pronounced in rice-wheat based cropping systems in the Indo-Gangetic plains, and some sugarcane growing regions in the western and southern parts of the country. Irrigation in India had undergone a rapid transformation post-independence. Growth of well irrigation had been at the expense of irrigation from tanks and other sources.

Climate is a direct input for the agricultural production process. Climate change is therefore expected to disproportionately impact developing countries, as they are closely tied to climate sensitive sectors like agriculture and which are already facing multiple stress due to population growth, urbanization, industrialization and globalization. As Indian agriculture continues to depend on weather making it sensitive to climate induced effects, any changes in the climatic factors like temperature, precipitation, carbon dioxide concentration, changes in the soil moisture would affect Indian agriculture. Among the most significant potential impacts of climate change on India are changes in the monsoon pattern. Due to climate change, Indian agriculture was doubly vulnerable. First as around 60 per cent of India’s total agricultural areas were rain-fed, it was highly vulnerable to climate change impacts on monsoon. Secondly, more than 80 per cent of farmers in India were small and marginal (having less than 1 ha of land) thus having less capacity to cope with climate change impacts on agriculture.

Chapter five measures the sustainability of Indian agriculture using Malmquist productivity index approach. The productivity performance in post WTO period was measured by the growth in Total Factor Productivity (TFP), taken as a proxy for sustainability showed considerable variations across crops and regions. Paddy enjoyed a substantial improvement in TFP averaging at 3.6 per cent during the study period. On the other hand TFP for Wheat production averaged at a meager 0.8 per cent during the study period. This was in conformity with the fact that present techniques of Wheat production reached a limit. Stagnancy was visible in traditional Wheat growing areas where intensive input use was aggravating the problems leading to unsustainable use of inputs. Within the Indian grains segment, performance of Maize was dramatic. It emerged as the third major food grain crop and the most important coarse cereal. The results indicated that TFP in Maize production averaged at 2.5 per cent during the study period. This growth was largely driven by rising adoption of hybrid seeds from the private sector and demand for feedstock due to rapid growth in the poultry sector. The results indicate that the TFP in Bajara production averaged at
3.2 per cent during the study period. This was an impressive performance mainly because of the adoption of modern varieties (MV) of seeds; the adoption rate of MVs of coarse cereals has reached about 80-100 per cent in the irrigated areas. The results indicated that the total factor productivity change TFP in Jowar production averaged at 3.9 per cent during the study period. Jowar has also benefited from an improvement in technology in terms of better quality seeds. Thus the performance of coarse cereals in terms of TFP was impressive.

The results indicated that the TFP in Cotton production averaged at 4.1 per cent during the study period. The increased performance of cotton in recent times can be explained in the background of introduction of Bt cotton in India. Productivity was substantially higher for Bt cotton than that for non-Bt cotton varieties. The cost efficiency as well as profit per hectare was also found to be higher for farmers cultivating Bt cotton crop. For Sugar the results indicated that TFP averaged at a negative value of -0.9 per cent during the study period. The post-Green Revolution phase was characterized by high input-use and decelerating total factor productivity growth. Sugarcane productivity attained during the 1980s was not sustained during the 1990s and early 21st century. Despite large area under sugar cultivation, productivity and yields were unimpressive, especially where the crop was irrigated. The results indicate that TFP in Jute production averaged at a negative value of -0.2 per cent during the study period. This implied a need for technological breakthrough to bring Jute out of the prevailing stagnancy. Cotton was the only commercial crop to perform well especially because of technological breakthrough achieved with the introduction of Bt. Cotton. TFP for Groundnut production averaged at a negative value of -0.1 per cent during the study period. While TFP in Soya production also averaged at a negative value of -0.6 per cent during the same period, full potential of the oilseed sector had probably not been realized either through the improved production techniques or better application of the available technology with the result Soybean yield in India was 0.95 tons per hectare, which was quite low, compared to other major Soybean producing countries. The results indicate that the TFP in Arhar production averaged at a value of 1.1 per cent during the study period. The results indicate that TFP in Gram production was almost stagnant with an average of 0.1 per cent during the study period. Pulses remained one of the weak spots in Indian agriculture. Shortage of pulses will thus continue to be a cause of concern in the near
future. The input support as well as the institutional support in pulses continued to remain weak.

At the state level, the highest growth in TFP in paddy production was experienced in Bihar, followed by Uttar Pradesh, Andhra Pradesh, and Punjab. West Bengal was the only state (among the states studied) which showed a negative growth rate. Growth had thus reached a limit in case of already developed states like Punjab; earlier backward states however, started benefitting from advanced technologies and had begun to catch up over the years. Except for Madhya Pradesh, all other wheat producing states had benefited from TFP growth. The highest TFP growth among states had been observed in Rajasthan, followed by Haryana and Punjab however, the value of TFP for both the states was less than one. The highest growth rate in Rajasthan suggested that the states which had initially not benefitted from green revolution were also catching up with technological improvements, while states like Punjab and Haryana had reached a level of stagnation. Substantial growth and efficiency in maize production was observed as a result of improved technology in Andhra Pradesh followed by Karnataka. Rajasthan was the only under-performing state. The performance of coarse cereals was substantially higher in irrigated states compared to states with lower irrigation facilities; such states were also doing better in adoption of modern varieties of seeds. In case of Jowar, Uttar Pradesh had done better than Maharashtra and Rajasthan with comparatively lesser irrigation availability.

Technology had brought substantial growth and efficiency in cotton with the introduction of Bt. Cotton. The highest growth rate, among states, was observed in Andhra Pradesh followed by Gujarat and Maharashtra. This points out that Bt cotton worked well in the irrigated areas. For Jute, ironically all the three states studied had a negative value for TFP. Assam was the worst performer followed by Orissa and West Bengal. Jute needed a technological breakthrough to come out of the prevailing stagnancy. In case of Sugarcane, Tamil Nadu performed the best among three states studied, Maharashtra, an important sugarcane producing state, performed badly. Sugarcane productivity during the 1980s was not sustained during the 1990s and early 21st century and posed a challenge for the researchers to shift production function upward by improving the technology index. Despite a lacklustre performance by major oilseeds (Groundnut and Soyabean) at national level, groundnut performed well
in Andhra Pradesh. Gujarat and Tamilnadu however, did not perform well. Similarly for Soyabean, Madhya Pradesh fared well while Maharashtra performed badly. This clearly indicated that full potential of the oilseed sector was not realized. The input support as well as the institutional support in pulses continued to remain weak. Furthermore, farming of pulses was still in its initial phase of technological change and was not enough technological break-through in pulses to make pulse farming as remunerative as other competing crops. Uttar Pradesh was the best performing state in *Arhar* cultivation followed by Maharashtra while Madhya Pradesh had performed badly during the study period. Gram production was poor at national level as well in Rajasthan and Uttar Pradesh Madhya Pradesh however had an excellent performance with a TFP value of 3.8 per cent.

**Chapter six** studies trends and distribution of poverty in India, it also includes a district level analysis between productivity and poverty. The regional differences in poverty reduction were substantial across India; as incidence of poverty varied largely across states. On the one end states like Himachal Pradesh and Jammu and Kashmir had poverty ratio within a single digit. While in Bihar more than 50 per cent of the population remained below the poverty line, around 40 per cent of the population were below poverty line in Orissa. Incidence of poverty also varied widely across social groups. High incidence of poverty prevailed among the scheduled tribe and scheduled caste population; these communities had suffered from social and economic exclusion for centuries in India. Among the religious groups, Sikhs had lowest HCR in rural areas whereas in urban areas, Christians had the lowest proportion of poor. Muslims had the highest HCR in both Rural as well as urban areas. The occupational composition of rural poor varied across the states. In general, in developed states, poverty was highly concentrated among agricultural labour households and in contrast in backward states poverty extended to other occupational groups including self-employed in agriculture. Wage earners in agricultural and non-agricultural sectors were almost equally poor. Poverty was the least among the salaried group followed by the self-employed in non-agriculture sector. Poverty among self-employed in agriculture was higher than the average for all groups. Incidence of poverty was the highest among the wage earning class.

The study found an inverse or negative relationship between agricultural productivity and poverty reduction, which means an increase in productivity, would
result in reduction of poverty. This clearly indicated that as productivity would improve it would bring about a decline in poverty. Significant results were found even when share of SC/ST population and Literacy rate were used as control variables. As expected, the result remained same in terms of direction, though the magnitude declined. This clearly demonstrated that without controlling for SC/ST and Literacy the equation will produce results with upward bias. Regression was carried out by adding agro-ecological zone as dummies in addition to SC/ST and Literacy controls. The magnitude of the variable of interest declined further, but, direction and significance did not change. This clearly established an inverse relationship between poverty and productivity.

The study was extended further at the regional level to establish the link between poverty and productivity across various agro-eco-zones (coastal, hill, irrigated, and rain fed). The result for coastal region showed a negative and significant relationship between poverty and productivity. The result for hill region however showed insignificant relationship between poverty and productivity. These results were expected, as in such regions poverty was determined by factors other than agriculture because agriculture was not an important economic activity in hills. The results were significant for irrigated zones of the country and were significant even after controlling for SC/ST population and level of literacy in the zone. The results were also significant for rain-fed regions. In rain-fed regions, productivity influenced poverty reduction more than in irrigated regions. It was interesting to note that the magnitude of variable of interest was higher for rain-fed region than irrigated regions. This clearly implied that as expected rain-fed districts were responding at higher rate than irrigated districts as a consequence of improvement in productivity. The main reason for this finding was that rain fed districts had higher poverty than irrigated districts to begin with. The results suggest that sustainable agriculture growth driven by yield gains can provide an effective way of fighting poverty.

Chapter seven gives a brief summary and conclusion of the entire study. It also gives following suggestions to promote agricultural sustainability and reduce poverty.

- Improvement in Productivity
- Promote Environment Friendly Agricultural Practices
- Enhanced Research & Development in Agriculture
Promoting Crop Diversification

Targeting Global Markets

Efficiency in Credit Delivery

Providing Employment Opportunities Outside Agriculture

Promotion of Pro-Poor Growth Process

Insulate Poverty through Food Security

Develop a Sustainable and Poverty-Reducing Approach to Agricultural Growth

Allocation of resources for eliminating poverty