Chapter 2
Review of Literature

Having briefly introduced the topic, visiting the theories put forth by scholars for transformation of agriculture, underlying the objectives, hypotheses and research design in the previous chapter, an attempt has been made here to review the existing studies undertaken by the researches on the theme of our thesis. These studies are expected to throw useful insights on various dimensions of agricultural development at the regional and sub-regional levels. A very large number of studies on different dimensions of agricultural development at international, national and sub-national level are available in the literature. It is neither feasible nor desirable to include all the available studies in the present chapter. Only selected studies are chosen which are directly related with various objectives of the present study.

2.1. International level studies

Bhattacharjee (1955) studied the resource use and productivity in World agriculture, taking 22 selected countries for 1948-50. Cobb-Douglas production function was used by taking six independent variables; population active in agriculture, arable land, fertilizer, work stock, productive livestock and tractors. He concluded that fertilizer consumption, weighted arable land and number of people active in agriculture were significant items of input whereas productive livestock, work stock and tractors did not show any significant regression. Marginal productivity of significant factors was computed that showed Marginal Productivity of fertilizer was the highest followed by labour in agriculture and weighted arable land was lowest among three.

Hayami and Ruttan (1970) found wide disparities in agricultural productivity across 38 selected countries for 1952-1966. The underdeveloped countries like India had only one-fifth of productivity level attained by the developed countries. They further classified the sources of productivity growth into three groups: resource endowments; technology as embodied in fixed or working capital, and human capital that included education, skill, knowledge and capacity embodied in country’s population. It was found that these three categories accounted for approximately 95 percent of differences in labour productivity in agriculture between selected countries. They recommended additional allocation of resources and investment in
industries producing technical inputs to achieve higher output per worker through increased output per unit of area.

Nair (1980) studied the pattern of technological progress and its impact on agriculture in the sixties and seventies in 20 countries of the world. He concluded that food production registered an impressive growth rate in most of the developing countries. In India, food production registered a growth rate of 2.27 percent per annum during the study period. Inputs like irrigation, chemical fertilizer, mechanization, high yielding varieties and insect pest control led to higher productivity in the agricultural sector. Irrigation was not found to be the explanatory variable for yield in all the countries except for India, China and Japan. Tractor use was the factor for variation in developing countries. Chemical fertilizer was crucial for higher yields. Level of irrigation, farm profitability and tractor use led to substantial use of fertilizer in India and Japan.

Kawagoe and Hayami (1983) compared labour and land productivities among the 44 countries during 1960-1980. It was found that the differences in labour productivity between developed and less developed countries were extremely large and also widened from 1960 to 1980. However, the growth of land productivity in less developed countries kept up with developed countries. A major factor for the widening gap in labour productivity was increased land-labour ratio in developed countries and decreased in less developed countries owing to population explosion. Developed countries were able to increase the labour productivity very rapidly by exploiting the opportunity opened by reduction in labour force through development of labour saving technology. The widening gap in land productivity between developed and less developed countries resulted from widening differences in land and capital per worker and widening differences in rate of growth in production efficiency that stemmed from the difference in the scientific research and development.

Naher (1997) studied the nature and degree of instability in production and yield of foodgrains and the extent to which food self sufficiency was reached through the introduction of green revolution in Bangladesh during 1969-70 to 1991-92 and its sub periods- phase I (1969-70 to 1976-77), corresponding to low keyed adoption of the new technology and phase II (1977-78 to 1991-92) corresponding to increased usage of technology. The study was at the aggregate and the regional level for rice, wheat, gram and total cereal production in the country. It was found that the most important impact of green revolution in the country was increase in the cropping intensity each year due to accelerated use of fertilizers, irrigation,
High Yielding Variety seeds and modern technology. The foodgrain sector achieved impressive growth rates since mid 1970s and the increase in rice production, the main staple food of the country showed stable trend that helped the country towards self sufficiency and removing the gap between availability and demand.

Wu (1997) focused on reforms in China’s agriculture since 1978, their impact on China’s internal and external economies and future reforms and their possible trade implications. He found that China’s post-1978 agricultural reform brought significant positive impact on the Chinese economy in general and China’s rural and agricultural sector in particular. Markets replaced central planning and helped in agricultural production and trade. Agricultural resources including land and labour were increasingly reallocated in accordance with China’s comparative advantage. However, the author found that China’s agricultural reform was not completed because of the Government’s commitment to grain self-sufficiency, control over agricultural land, labour and other resource mobility and policy interventions through erratic price changes. He concluded that if China continued to adhere to its food self-sufficiency policy, rapid industrialization would make land-intensive agriculture more costly and if it wants to keep its domestic food prices at world market levels, it will have to import more land-intensive food and diversify its resources towards more export oriented industrial goods.

Karshenas (1999) studied the role of agriculture in economic development in Sub-Saharan Africa and Asia. It was found that in the case of Asian countries, the existence of an abundant supply of labour in agriculture allowed fast rates of industrial growth to take place at low and competitive wages, creation of an adequate infrastructure and integration of the agricultural sector in the national market. This led to the complementary and mutual growth of agricultural and non-agricultural sectors. However, in the case of sub-Saharan African economies, with limited supply of labour and relative abundance of cultivable land, the non-agricultural sectors faced relatively high and steep wage curves. The lack of basic infrastructure, lack of capital and appropriate technologies to alleviate the agricultural labour constraint in most African countries prevented the integration of a large part of the agrarian economies into the national and international market. The author suggested for the substitution aspect of sectoral growth rates and the policy lessons to take into account specific country characteristics.

Kurosaki (2001) quantified the contribution of changes in crop mix to agricultural growth for the areas currently in India and Pakistan for the period c.1900-1995. A decomposition
method was applied that showed a significant part of land productivity growth was attributed to changes in crop mix in post-independence India and in areas currently in Pakistan (pre and post-independence). It was found that land reallocation toward high value crops was the main engine of agricultural growth during the pre-green revolution period (after independence) for Pakistan. In India, in contrast, the importance of changes in crop mix to land productivity growth had been increasing throughout the post-independence period. Estimated patterns of the sources of land productivity growth were found to be consistent with the hypothesis that development of rural markets and improvement in agricultural technology were key to the realization of farmers’ economic rationality. He concluded that sustained growth in agriculture can be achieved with public investment in agriculture.

Debela, Heshmati and Oygard (2004) analyzed the performance of agriculture in post reform Ethiopia by measuring technical, allocative and economic efficiency, productivity growth, and technological progress using stochastic frontier production function. The results indicated evidence of significant technical and allocative inefficiencies among the farmers and on the other hand allocative and economic efficiency deteriorated over the period. The findings from the growth accounting suggested that technological regress contributed the largest share of output decline during the period. Increased fertilizer use by 105.9 percent didn’t contribute much to output growth because of the small size of elasticity of output with respect to fertilizer. The key policy agendas suggested by the authors were to reverse the land degradation process, investments in agricultural research, training, transport and communication infrastructure, rehabilitation and conservation and human capital and the government to ensure availability of credits and tenure security.

Barrios (2007) proposed agricultural growth model to verify the agricultural convergence hypothesis among 27 Asian countries that included Developing Member Countries (DMCs) of ADB excluding Japan, other non member Asian countries and Pacific countries for the period 1995–2005. There was significant evidence of conditional convergence among some Asian countries. The effect of spatial externalities defined by participation of a country in international trade, country-specific random endowments, and temporal accumulation were found to be significantly contributing to agricultural growth. Whereas, public expenditures for agriculture and foreign aid did not record any direct effect on agricultural growth, they however facilitated countries’ movement towards the steady-state production rate leading towards convergence. The author concluded that conditioning on current trade, foreign aid and public expenditures for agriculture, Asian economies would converge in agricultural
growth at the rate of approximately 15 percent per year. He suggested that to effectively achieve the goals of regional integration, careful matching among countries engaged in bilateral or multilateral agreements should be done to facilitate convergence in agricultural growth.

**Breisinger et al (2008)** discussed the role of agriculture in growth and development of Ghana and a tool for poverty reduction during 1990-2006. It was found that the agriculture growth was more rapid than the non-agriculture sector, expanding by an average annual rate of 5.5 per cent, compared to 5.2 percent for the economy as a whole. Agriculture supported the rest of the economy through substantial and largely invisible monetary transfers to the non-agricultural sectors. Despite the country’s sound agricultural performance over the past years, it was found to be challenging for Ghana to sustain and accelerate this growth, particularly if external conditions become less favorable in the future. The authors suggested the future growth of agriculture by closing existing yield gaps and increasing the efficiency of available land use through substantial investments in green-revolution type of investments, including rural infrastructure, marketing, extension and agricultural research and development.

**Afzal and Ahmad (2009)** analyzed the agricultural input-output relation in Pakistan and found that the improved seed had higher relation with fertilizer (83 percent) and water (72 percent) than electricity (49 percent) i.e. water and fertilizers were essential to harvest the benefits of improved seed. He suggested increasing the water and energy use efficiency in future because water is a finite resource and there is acute shortage of electricity in Pakistan. Fertilizer had the strongest relationship with water (95 percent), followed by seed (83 percent) and electricity (72 percent), this indicated that water was essential to harvest the benefits of fertilizer and electricity. The author suggested for improvement of input use efficiency in agriculture such as reduction in per capita water availability, rise in population, less than the optimum level availability of improved seed, imbalance use of fertilizers, rise in diesel prices and electricity tariff and lack of institutions to provide timely services to farmers.

**Xin and Qin (2009)** studied the regional disparity of China’s agricultural productivity growth by decomposing it into technical changes, efficiency changes and input accumulation per worker. The convergence test was used to analyze the determinants of regional disparity. The authors found that during 1987 and 2005, the growth of China’s agricultural labour productivity depended on the accumulation of inputs and technical changes contributed more
to the regional disparities in agricultural productivity growth. The increase in inputs for Western China, and the improvement in technical change for Central and Western China were found to be significant aspects to promote the growth of agricultural productivity and narrow the gap in agriculture productivity with the Eastern China.

**Piya, Kiminami and Yagi (2011)** focused on the analysis of sources of land productivity in South and Southeast Asian countries during 1980 to 2007. It was found that land productivity and input intensification widely varied across South and Southeast Asian countries. The use of modern inputs like chemical fertilizer and tractor was found higher in Southeast Asia while the use of traditional inputs like livestock and labour were found higher in South Asia. The growth accounting suggested that the growth in fertilizer and tractor usages were the main sources of land productivity growth. Average annual production growth was higher in Southeast Asia compared to South Asia. Decomposition of production growth into land productivity and land area indicated that only land productivity growth explained the growth in agricultural production in South Asia while land productivity as well as land expansion explained the production growth in Southeast Asia.

**Rehman, Saeed and Salam (2011)** analyzed the trends in area, production and yield of wheat, rice, sugarcane and cotton crops in Pakistan agriculture using component analysis model during pre-structural adjustment period (1972 to 1988) and post-structural adjustment period (1989 to 2009). They found that growth rate of major crops, except rice, was better in pre-structural adjustment period than under the post-structural period. The results of decomposition analysis found that during the pre-adjustment period, increase in output was predominant in case of wheat, rice and cotton due to the yield effect and in sugarcane crop due to area effect. In the post-structural adjustment period, the source of output growth in wheat and cotton was due to yield effect and due to area effect in sugarcane and rice crops. For the overall study period, for wheat and cotton crops, the major growth factor was the yield effect, but for sugarcane and rice it was the area effect. The aggregate result for all crops recorded that the production growth was mainly due to yield effect during the pre-structural adjustment period and due to area effect during the post-structural adjustment period. However for the overall study period 1972-2009, the area and yield effects contributed equally towards the total change in output growth for aggregate crops. The authors thereafter suggested policies focusing on developing new high-yielding varieties to increase crop production in Pakistan, research efforts to strengthen the crop breeding
programs and to develop and establish the bio-technology programs to develop high yield varieties of the crops suitable to agro-climate conditions of the regions.

**Taffesse, Dorosh and Asrat (2011)** discussed patterns and trends of crop production in Ethiopia for all crops during 2004-05 to 2007-08 and for cereal crops from 1961-62 to 2008-09. It was recorded that five major cereals (teff, wheat, maize, sorghum and barley) occupied almost three-quarters of total area cultivated, and represented almost 70 percent of total value added in the country. Decomposition analysis recorded that during the 1990s, most of the increase in cereal production was due to increases in area. However, in the 2000s, area and yield increases, each accounted for about half of production growth. The authors suggested increasing cereal crop yield for its growth by adopting improved seeds, chemical and organic fertilizers and to diversify and shift to higher-value crops.

**Udensi et al (2012)** studied the determinants of macroeconomic variables that affect agricultural production in Nigeria between 1977 and 2007. They found that total government expenditure on agriculture, nominal exchange rate, interest rate and total credit accessed by farmers from commercial banks were all positively related with the index of agriculture production and were all significant at 1 percent level of significance. Government expenditure on agriculture was found to be the most important variable required to cause growth and development in the agricultural sector in Nigeria. They suggested to design sector-specific agricultural policies to facilitate increased long-term sustainable government investment in agriculture, foreign private investment in agriculture, favourable exchange rate, availability of credit at low interest rate, reduction of annual rate of inflation and farmers to respond positively to the opportunities that emanate from soaring global food prices to increase agricultural production in Nigeria.

**Alamian, Eshraghi, and Joolaie (2013)** analyzed the components of agriculture growth in Golestan province in Iran using multiplicative decomposition method during 1991-92 to 2010-2011. The authors found that the price growth was the main factor of agriculture growth and there was lack of an appropriate improvement in land productivity growth as well as the cropping pattern growth. The authors therefore, stressed on revision in the development policies of agricultural crops production to increase the productivity in the agricultural sector and suggested for government investment in agricultural infrastructure and research to develop high-efficiency organizations along with change in supportive policies to change the exchange rate between the agricultural items and the products of other sectors, paying
attention to the exploited potentials from the pioneer farmers and its propagation among the other producers, development and propagation of more appropriate methods for cultivations, rearing and harvesting and more appropriate organization of production to increase the role of productivity factor in the production growth of agricultural products and decrease the need of increasingly growth of prices.

2.2. National level studies

Abraham and Raheja (1967) analyzed the growth of production for rice and wheat in India during 1951-52 to 1964-65 examined the contribution of input factors like area, irrigation and fertilizer. It was found that the unirrigated area, irrigated area and fertilizer consumption accounted for about 7.14 percent, 15.84 percent and 77 percent respectively in the rice production and 30 percent, 35 percent and 35 percent respectively of the growth in wheat production.

Brown (1971) was probably first to undertake the comprehensive district wise analysis of pre-green revolution Indian agriculture. The study was based on data for 19 major crops, 320 districts including 15 Intensive Agricultural District Programme (IADP) districts during 1956-57 to 1965-66. With only exception for Ludhiana, Surat and Mandya, change in yield level of remaining 12 IADP districts was similar to other non-Intensive Agricultural District Programme districts. The author found that the inter-district variations in yield and growth rate of output were due to combined impact of favourable soil, adequate irrigation, rainfall, cost reducing technology and fertilizers used. He concluded that Intensive Agricultural District Programme districts did not show significant different performance than other non-Intensive Agricultural District Programme districts in India.

Rao (1971) analyzed the factors responsible for inter-regional differentials in the growth of crop-output during 1952-53 to 1964-65. He found that the major cause of the disparities in growth of crop-output was the difference in growth of irrigation. The public investment played a major role in bringing the growth in irrigation, private investment was mostly confined to well irrigation. It was also argued that private investment was high where public subsidies and loans were easily forthcoming and where rainfall was scanty and fluctuating. According to the author, it was doubtful whether the ability to save was an important factor in explaining inter-regional differentials in private investments in irrigation or the growth of crop-output. Since rich farmers also happen to be concentrated in the better-off areas, they were able to induce greater public investments in irrigation in their regions.
Gordan (1974) studied the factors besides agro-climatic conditions that were associated with the variations in output per acre across the districts in 16 Indian states for 12 crops (rice, wheat, jowar, gram, bajra, maize, cotton, ragi, groundnut, jute, barley and sugarcane). Regression analysis was used to measure the degree of association between dependent variable (output per acre of various crops) and 19 explanatory variables including irrigation, multiple cropping, electrification, transportation and various measures of farm size, education, health facilities and health status. The author found that controlled water flow constituted a critical input necessary to obtain maximum yields. Education was an important contribution to human capital formation than improved health. Output per acre was large on small farms than on large farms and the factors responsible for this relationship were extensive irrigation, more intensive multiple cropping and in case of rice more labour intensity.

Easter, Martin and George (1977) examined the regional difference in agricultural productivity in 73 major wheat producing districts in states of Punjab, Haryana, Uttar Pradesh, Madhya Pradesh and Rajasthan and 69 rice producing districts in Eastern regions comprising of Eastern Uttar Pradesh, Bihar, West Bengal, Orissa and Eastern Andhra Pradesh. The information on crop area and output, irrigation, fertilizer, roads, and labour was used for 1959-60 and 1961-62 period. The author found that for wheat regions, the expansion of irrigation and improvement in quality of irrigation through tube wells led to substantial increase in productivity. However other variables turned out to be insignificant statistically. Results for rice region, also turned out on similar line with exception that irrigation variable was insignificant, whereas surface road had significant bearing on productivity differences among districts. The findings of the study did not bring out the role of modern inputs as determinants of inter-district disparities in agricultural productivity.

Alagh, Bhalla and Bhaduri (1978) argued that the main source of agricultural growth in India during 1960s was increased yield which was associated with a higher ratio of labour to land. A more intensive pattern of land use, resulting in higher yield and higher labour input per unit of land was the main source of growth of output and employment in agriculture. It was found that the districts that showed high rates of growth of agricultural output and land yield absorbed more labour per hectare and maintained higher labour productivity and vice-versa. Growth rates were achieved in agriculture mainly in areas where rapid extension of irrigation made possible high rates of growth of cropped area, high cropping intensity and significant expansion of area under high yielding varieties.
**Bhalla and Alagh (1979)** studied the comprehensive analysis of inter-district variations in growth and productivity in Indian agriculture. The study was based on crop wise information for 19 major crops and input used for triennium 1962-65 and 1970-73 and covered 282 districts from 17 major states in the country. On the basis of value output per hectare, the districts were classified into high productivity, medium productive and low productive districts. It was found that 69 high productivity districts accounted for 24.8 per cent of area, 36.4 per cent of total irrigated output, consumed 44.2 per cent of total fertilizers and employed 50.39 per cent of tractors and 45.47 per cent of tubewells for irrigation. These districts were mainly from the Western and Southern states: Punjab (9), Tamil Nadu (9), Kerala (7), Karnataka (5), Western Uttar Pradesh (5), West Bengal (5), Andhra Pradesh (5), Coastal Maharashtra (3), Haryana (1), and Gujarat (1). On the other extreme were 83 districts having low productivity less than Rs 700 per hectare. From 30.74 per cent of total area, these contributed 15.68 per cent of total output, consumed only 12.83 per cent of total fertilizers, 11.30 per cent of tractors, 19.0 per cent tube wells and 11.80 per cent of total irrigated area in the country. Low productivity districts were mainly distributed in the Central and Eastern parts of the country. With concentration of modern inputs in highly developed and high growth districts in the country, the authors concluded that modern inputs and irrigation were major source of growth and inter-regional variations in Indian agriculture.

**Alagh and Sharma (1980)** studied the growth of crop production during 1960-61 and 1978-79, dividing it into two sub periods- 1960-61 to 1969-70 (pre-green revolution) and 1969-70 to 1978-79 (post green revolution). They found that the growth rates for food grain production rose from 1.85 percent during the first period to 2.74 percent for the second period, while for the period 1960-61 to 1978-79, it was 2.77 percent. Punjab recorded the highest growth rates of 9.54 percent and 8.01 percent per annum for 1960-61 to 1969-70 and 1960-61 to 1978-79 whereas, Maharashtra led the second period (1969-70 to 1978-79). At the all India level, sugarcane output grew at the rate of 2.29 percent, 3.42 percent and 2.93 percent for the first, second and the third periods respectively. With regard to cotton, the trend of growth in output was 1.62 percent for the period 1960-61 to 1978-79. During 1960-61 to 1969-70, it was 0.31 percent which increased to 3.38 percent during 1969-70 to 1978-79.

**Dayal (1984)** identified and interpreted regional agricultural productivity patterns in India. Three indexes of agricultural productivity-land productivity, labour productivity, and aggregate productivity were employed to measure and map productivity patterns in India.
Large regional inequalities in the levels of productivity were recorded. Regression analysis revealed that the spatial variation of land productivity was positively related to fertilizer use, irrigation, and urban-industrial development and negatively related to population density. Labour productivity was positively associated with agricultural wages and fertilizer use and negatively with the density of agricultural workers on net sown area. Aggregate productivity was positively associated with fertilizer and irrigation use and negatively with the densities of population and agricultural workers. The significant explanatory variables in the regressions explained 61 percent of land productivity, 57 percent of labour productivity, and 42 percent of aggregate productivity.

Dev (1985) extended the Bhalla and Alagh (1978) district wise analysis of agricultural performance up to the period 1975-78. It was found that the share of 106 low productivity districts in the aggregate output declined from about 16 percent during 1970-73 to 11 percent during 1975-78 and that of 48 high productivity districts increased from 36 to 45 percent during the same period. The output per unit area for high productivity districts increased from Rs 1730 per hectare to Rs 1829 per hectare while that for low productivity districts declined from Rs 550 per hectare to Rs 481 per hectare.

Ranade (1986) studied the sources of growth of agricultural productivity during 1952-53 to 1982-83 in India. He found that the change in the rice productivity was highest in the last period (1972-73 to 1982-83) and lowest in the first period. The major contribution in agriculture production in the first period came from pure yield while during green revolution period, the cropping pattern and locational effect made a significant contribution to growth. The author also found that the technological change in rice production helped in tapering comparative advantage of some states like Punjab and Haryana. The locational effect was possible only after the technological change had taken place. As a result, the contribution of pure yield effect was more in pre-green revolution period than in the post green revolution period.

Bhalla and Tyagi (1989) analyzed agricultural performance at the district level in 17 major states for the periods 1962-65, 1970-73 and 1980-83, examined the association between growth rates and use of modern inputs and whether the degree of regional concentration of growth had increased or declined. The analysis was carried for 19 major crops and total crop sector for 41 crops. The authors found that introduction of new technology during 1962-65 to 1970-73 led to increase in the inter-district disparities in the productivity levels. However, the
spread of new technology during 1970-73 to 1980-83 led to increase in agriculture productivity as well. There was positive correlation between the levels of productivity, agriculture growth rates and use of modern inputs like fertilizers, tractors and tube wells. The authors suggested for proper policies and increased investments in the agriculture sector to increase productivity and reduce disparities.

Rana (1990) examined inequality in land productivity at the state level in India using cross section data for the year 1983. The author found that rainfall, per capita cropped area, short term interest rate for agriculturists and soil quality index played an insignificant role in affecting the land productivity, whereas irrigation and fertilizers were the only significant factors. He suggested for controlling the variation in the land productivity through larger allocation of funds for irrigation purposes in the states where land productivity was low and more use of fertilizers in the states where its use was lower in comparison to the progressive states, providing greater facilities of credit, higher support prices for the main crops in the low productivity states and effective plans by the government to control floods and transfer water to the states lacking irrigation facilities.

Singh and Chand (1990) examined the changes in the technological factors across states/regions and analyzed the inter-state disparities in the growth of agricultural production and productivity during 1970-71 to 1986-87. Time series data on production, technological parameters, infrastructural factors, mechanical power and total foodgrains production and productivity was used to calculate state-wise changes and growth rates. Large imbalances in the growth of agricultural production among the states/regions were recorded due to adoption of modern crop production technology, variations in the infrastructural facilities and use of mechanical power. Punjab, Haryana and Uttar Pradesh, where the changes in the adoption of new technology, development in the infrastructural facilities and use of machinery took place, agricultural production and productivity increased tremendously. However, the backward states such as Orissa, Madhya Pradesh, Rajasthan and West Bengal, where there were no changes in the technology, showed low growth rates in agricultural output. The policy suggestions included adoption of modern crop technology in the backward states/regions, more investment in the development of infrastructure facilities for irrigation, water management, land improvement, consolidation of holdings, marketing and provision of adequate credit to purchase agricultural machinery.
Alshi and Joshi (1997) studied the inter-state and inter-decadal variations in the performance of cereals, pulses and total foodgrains and yield differences due to the use of fertilizers, irrigation and HYV in India and in different states for the periods 1971-72 to 1980-81 and 1981-82 to 1990-91. The results showed that during seventies the performance of cereals varied among the states where Punjab and Haryana had the highest and Madhya Pradesh and Maharashtra had lowest yield and the disparities further increased in the eighties. In pulses also there was divergent performance among the states in seventies which continued in the eighties also. Punjab had the highest per hectare productivity while Andhra Pradesh had the lowest productivity during seventies. Foodgrains also recorded a divergent growth during seventies that further widened in the eighties and again Punjab had the highest growth followed by Haryana and Kerala whereas Rajasthan, Maharashtra and Madhya Pradesh lagged behind. There were large variations in the adoption of key inputs like irrigation, fertilizer and HYV and the states with higher level of use of these inputs exhibited higher productivity.

Bhalla and Singh (1997) analyzed the regional patterns of levels and growth of agricultural output at state level on area and output of 43 crops from 1962-65 to 1992-95 in India. The authors recorded acceleration as well as diversification in the growth rate of agricultural output in India during 1980-83 to 1992-95 as compared with the earlier periods. The period 1980-83 to 1992-95 also recorded cropping pattern changes away from coarse cereals towards rice and wheat cultivation on the one hand and towards oilseeds on the other. There was widespread acceleration in per male agricultural worker productivity in many Indian states during 1980s. The authors concluded that if high labour productivity growth would sustain then it would not only result in higher wages but would also trigger growth in the non-agricultural sector through input output and consumption linkages. According to the authors there is large potential in crop diversification and exports in Indian agriculture and small and marginal farmers play an important role in the process of diversification. Therefore appropriate institutional strategies should be devised to involve the small and marginal farmers so that they may avail the benefits of increasing growth, agricultural diversification and exports.

Singh, Rai and Karwasra (1997) examined the temporal and spatial performance of area, production and yield of foodgrain and non foodgrain crops and the factors responsible for determining yield and acreage of the foodgrain crops across the states and the country for the three time periods: period I (1960-61 to 1967-68), period II (1968-69 to 1980-81) and period
III (1981-82 to 1992-93). It was found that for foodgrains, the yield witnessed higher growth rates as compared to the acreage in the last two decades at the national level and at the state level. In case of non foodgrains, oilseeds and cotton maintained a steady trend in growth rates. The main determinants of agricultural performance were found to be the total cropped area, yield per hectare and irrigation water followed by regulated markets and road networks. It was also found that increased use of irrigation water, fertilizers and HYV seeds could increase the yield of foodgrain crops in most of the states.

Bhide, Kalirajan and Shand (1998) examined the patterns of agricultural growth and compared it with non agricultural sectors at the national as well as state level in India from 1950-51 to 1993-94 and tested for convergence of agricultural growth rates across states over time. They found that unlike the non-agricultural sectors, growth in agriculture was steady for almost four decades since 1950 and the statistical tests did not show any structural break in the growth pattern of agriculture. However when trend growth in output per hectare was considered, structural breaks occurred in the mid-1960s and in 1980s. Growth rates in agriculture exhibit marked cyclical pattern at the crop as well as state levels. The crop level cycles were attributed to movements in relative prices or other factors relating to market conditions, whereas the state level cycles were related to policies. The pattern of growth rates of agricultural output of the states over short periods of 5 years indicated that all the 15 states were converging to one rate of growth; but over a longer time period of 10 years, the states with higher proportion of crop area under irrigation were registered to be converging to higher rates of growth, whereas the states with lower proportion of crop area under irrigation converged to lower rate of growth. The policy suggestions included strengthening the investment climate in agriculture, by operating on both the supply and demand factors.

Bhalla and Singh (2001) analyzed the pattern, growth and sources of agricultural development for 17 states and 282 districts for the triennium, 1962-65, 1970-73, 1980-83 and 1990-93. The study covered 44 crops at the state level and 35 crops at the district level. It was found that during 1962-65 to 1980-83, the impact of new technology in transforming traditional agriculture was confined to North-Western and Southern regions and a few irrigated parts of Central and Eastern India. The spread of green revolution was slow during the first twenty years i.e. from 1962-65 to 1980-83 and gathered momentum during the 1980’s. There was a change in cropping patterns from coarse cereals towards oilseeds and other commercial crops. A substantial number of districts progressed to a higher level of development and growth, both in terms of land and labour productivity. The spread of new
technology to the Eastern region was the most important development during 1980s. The authors suggested for balanced regional and substantial development of Indian agriculture, there is need for diversification of agriculture from low value coarse cereals to high value fruits and vegetables, investment in rural infrastructure including irrigation, rural roads and electrification, increased allocation to agriculture research and development, animal husbandry and fishing, consolidation of land holdings and continuation of policy of minimum price supports programmes.

Joshi, Birthal and Minot (2006) examined the sources of agriculture growth during 1980s and 1990s at the national and regional level in India. The analysis concluded that at the national level, technology (yield increases) was the prime mover of growth during 1980s, while rising prices and diversification were the dominant source of growth in agriculture during 1990s. At the regional level, in Northern and Eastern regions, prices increase was the most important source of growth during 1990s, whereas in Southern and Western regions, crop income growth was led by diversification into higher value crops. The policy suggestions included investment in agricultural research and development, diversification of agriculture, infrastructure improvements, and institutional development to link small farmers with markets.

Mathur, Das and Sircar (2006) examined the trends, factors and constraints and inter-regional variations in growth of agricultural production in India during 1990-91 to 2003-04. The authors recorded decline in the growth of agriculture sector during 1990s till the recent past accompanied with decline in yields per hectare in food crops. The yield of different crops in the country was below the world average except for wheat and sugarcane. The state wise analysis also showed wide variations in growth from 28 percent to 19 percent for first three years and last three years- 1993-96 and 2000-03. It was found that at the state level the agricultural output at current prices was significantly and positively dependent on government expenditure on agriculture, fertilizer usage, rainfall and population.

Chand, Raju and Pandey (2007) examined the trend in agricultural growth and factors for slowdown in agriculture at the national and state level since 1980s. They found that the initial years of reforms were favourable for agricultural growth, but the post WTO period witnessed a sharp decline in the growth rate of all sub sectors and commodity groups in the agricultural sector. At the state level, the growth rate was negative in four out of 20 major states while six states showed growth rate between 0.10 and 0.95 percent. However, the growth rate of
agriculture in most of the low productivity states was much higher than the national average during 1984-85 to 1995-96. But after 1995-96, their growth rates declined and were much lower than the national average. To revive agricultural growth, the authors suggested to exploit irrigation potential, increase power supply, fertilizer use, credit facilities to farmers, competitive markets, and improvement in terms of trade in agriculture and mitigate risk in farming.

**Mishra (2007)** analyzed the trends in agriculture growth and decomposed growth using Minhas-Vaidyanathan decomposition scheme in India during 1951 to 1998. It was found that introduction of high yielding varieties in wheat, maize and rice along with improved irrigation facilities led to significant increase in their yield rates and cash crops such as cotton, sugarcane and jute recorded two-fold increase in their yield rates. Decomposition analysis recorded that the percentage contribution of change in yield rate was the most dominant component of agricultural growth. And the percentage contribution of change in the gross area under cultivation was the second most important factor of agricultural growth. However, during 1981-91 and afterwards, the interaction component between area and yield was better than area effect and change in cropping pattern was only a marginal component of agricultural growth. However, interacting with changes in gross area and yield rate significantly contributed to agricultural growth.

**Singh (2007)** analyzed agriculture performance and labour productivity for 45 crops across 581 districts from 33 states and Union territories in India during 1990-93 to 1999-2002. Considerable variations in agriculture were recorded where 175 most developed districts contributed about 50 percent to total agriculture production with only 27 percent land resources, whereas on other side 231 most underdeveloped districts contributed only 27 percent to production with 50 percent of cultivated land. Western-Central region recorded most of the agriculturally low developed districts whereas, most of the districts in Northern region were high developed. In case of labour productivity, Eastern and North-Eastern regions recorded maximum number of low productivity districts. Agriculture growth also recorded deceleration during 1990s in majority of the districts. For rapid, inclusive, equitable and sustainable development, he suggested for up-gradation in technological base, successful adoption of biotechnology and rehabilitating the productive capacity of the soil. Strengthening of research, market infrastructure and other institutions, consolidation of land
holdings, formalization of contract farming and development of agro-processing industries, and human resource development.

Sahoo and Mohapatra (2008) focused on inter-state disparities among the 15 major states of India from 1981-82 to 2002-03. The better performing states were mostly in the Western and Southern regions of the country. On the other hand, the non-performing or poorly performing states were in the Northern and Eastern regions. There was a decrease in the disparity across the states in both Net State Domestic Product (NSDP) and Per capita Net State Domestic Product (PNSDP) over the years but the disparity continued to be very high and relatively higher in the Net State Domestic Product compared to Per capita Net State Domestic Product. There was also strong evidence of cyclical nature of the disparity across the states, implying that agriculture was highly dependent on nature and other stochastic factors that caused fluctuations in the output across time and space. The agricultural growth decelerated in the agriculturally developed states like Punjab, Haryana and Western Uttar Pradesh in the post-reform period. Some agriculturally poor states like Bihar and West Bengal had shown a significant improvement in their agricultural growth. The regression results showed that the disparity in the agricultural output was significantly and positively affected by the variations in fertilizer use and the length of pucca roads.

Venkateswarlu (2008) analyzed the changing policy perspectives and the performance of Indian agriculture in the post-independence period. He discussed agricultural development during: first phase of pre-green revolution period (till mid 1960s) where implementation of land reforms was undertaken; in the second phase i.e. during the green revolution period (1966-91) when bio chemical and mechanical technologies were adopted; and the third phase was the post reform period when Indian agriculture was influenced by the SAP (Structural Adjustment Programme) and India’s entry into the WTO. He noted that during green revolution period, India achieved self sufficiency in food grain production with high yield growth. However in the post 1991 period, there was deceleration in growth rates for all crops including food and non food and the growth rates of agricultural GDP and rural employment also decreased. The author suggested for adoption of proper plans and policies and the government to play a vital role for the development of agriculture sector.

Bhalla and Singh (2009) analyzed the impact of economic reforms on the levels and growth of land yields and agricultural output at the state and regional levels for 17 major Indian states and 44 crops. The entire period of the study was divided into initial period of green
revolution (1962-65 to 1980-83), maturing of green revolution (1980-83 to 1990-93) and post liberalization period (1990-93 to 2003-06). It was found that the spread of new technology during 1960’s remained confined to irrigated states mainly the North-Western region of India. However the new technology matured during 1980-83 to 1990-93 and spread widely to more areas and crops that resulted in growth rates of yield, output and agricultural worker productivity. There was acceleration in the growth rates from 2.24 per cent in 1962-65 to 3.40 per cent and change in cropping pattern during the period. But the post reform period 1990-93 to 2003-06 was characterized by retrogression in the level and growth rates of yield and output and slowdown in diversification towards oilseeds. The reasons for the slow-down were decline in public investment in irrigation and water management, decline in scientific research as well as slowdown in diversification.

Singh and Singh (2009) studied the temporal and spatial pattern of agricultural growth in the pre and post reform period across 17 major states in India. The analysis indicated that growth rates of agricultural output and productivity registered a sharp decline since the early nineties at the all India level as well as in most of the states. There was a downtrend in the growth of area expansion, irrigation and fertilizer consumption due to decline in public sector investment in agriculture coupled with a policy of reduction in subsidy and declining support to the public procurement system. The process of economic reforms largely bypassed the agricultural sector and the external environment also did not give the expected boost to agriculture due to declining trend in world prices, continuation of the high level of subsidies in the developed countries and resort to non tariff barriers. It was found that price reforms alone would not be an effective instrument of agricultural growth without support in the form of rural infrastructure, technology and institutional reforms.

Tripathi and Prasad (2009) evaluated performance, progress and sources of agricultural growth in India since 1950-51 to 2007-08. It was found that agricultural workforce shifted from cultivators to agricultural labours, the number of uneconomic holdings had an increasing trend, area under food crops shifted towards non food crops, and within food crops area under cereals shifted towards non cereals, growth trend of aggregate agriculture as well as all sub sector of agriculture except forestry declined during post-WTO period, production and yield instability declined for almost all crops during post reform period while area instability increased. The decomposition analysis indicated that rising output per hectare was the predominant source of agricultural growth for most of the crops and crop groups. Disaggregating of reference period in four sub periods showed that expansion of agricultural
land was the main source of agricultural growth during the period before 1965-66 and after that the contribution of increased land area under agricultural production had declined over time and increase in productivity became the main source of growth in agricultural production. The estimation of aggregate agricultural production function with both intercept and slope dummy indicated that land significantly affected the agricultural output growth during 1950-51 to 1964-65 and after that land became less significant and now labour and capital were significantly affecting the agricultural output growth.

Birthal, Singh and Kumar (2011) investigated convergence and catch-up among 15 Indian states during 1980-81 to 2004-05 and examined the role of agricultural conditions during convergence or divergence. They found that income growth accelerated in middle income states, decelerated in most rich states and neither accelerated nor decelerated in poor states. However, there was no evidence of σ-convergence as well as absolute β-convergence in income levels across Indian states, indicating no tendency of states to converge to an identical steady state. In contrast, robust evidence of conditional β-convergence was found. It was found that investment in physical infrastructure and human resources alone was not sufficient for convergence. It should to be accompanied by an improvement in agricultural conditions in particular with regard to employment pressure and technological change. According to them, for convergence it was imperative to reduce employment pressure on agriculture by improving labour market linkages of agriculture with non-agricultural sectors and technology-led intensification of agriculture to promote agricultural as well as overall economic growth and speed up process of convergence.

Kannan and Sundaram (2011) discussed the trends and patterns in agricultural growth at the national and sub-national levels in India for 44 crops in 17 major states during 1967-68 to 2007-08. They analyzed that the cropping pattern in India has undergone significant changes over time with a shift from cultivation of food grains to commercial crops. Increase in crop yield was found to be a major factor for accelerating crop production since 1960s. The authors concluded that the enhanced capital formation, better irrigation facilities, normal rainfall and improved fertilizer consumption helped to improve crop output in the country and there is further potential for enhancing yield of major crops through better soil and water management, profitable crop rotation, innovative marketing, genetic engineering and investment in farm education and rural infrastructure.
**Bhalla and Singh (2012)** analyzed the regional patterns of levels and growth of agriculture output, labour productivity and their association with inputs used at the district, state and regional level during post reform period from 1990-93 to 2005-08 and compared it with agriculture performance during pre-reform period from 1962-65 to 1980-83. The study was undertaken for 44 crops and 281 districts. It was found that adoption of seed fertilizer technology along with irrigation expansion during green revolution phase led to acceleration in output growth. During initial years of green revolution, there was inequality at the regional level but it declined thereafter. However, post reform period led to decline in agriculture performance and growth rates declined from 3.17 percent to 2.77 percent per annum during green revolution phase to post reform period. Except Gujarat and Maharashtra, growth rates declined in all states during post liberalization period. This decline was due to decline in public investment and lack of fresh technological breakthrough in agriculture.

**Chand and Parappurathu (2012)** analyzed the trends in agricultural productivity at the national and state level to identify the major factors responsible for the varied performance of agriculture during 1960-61 to 2010-11 in India. It was found that green revolution technologies introduced in the late 1960s led to significant acceleration in growth from below 1 percent to 3 percent as well as diversification of production towards horticultural and cash crops. However, the post-reform period witnessed a deceleration of growth in most of the crops due to diversion of resources away from agriculture and decline in public and private investment. The use of primary inputs in the sector also slowed down, which led to decline in the yield levels. The retardation of growth continued up to 2004-05, after which there was a sharp recovery. According to the authors, this was mainly due to hike in public and private investment and a substantial improvement in terms of trade in favour of the agriculture sector and this led to rapid expansion of agricultural credit, reinvigorated growth in the distribution of quality seeds and favourable prices of farm products.

**Kumar and Jain (2013)** examined the trends in growth and instability in Indian agriculture at the district level for the period from 1990-91 to 2007-08. They found that proportion of districts recording very low productivity declined from 9.4 per cent in TE 1991 to 3.3 per cent in TE 2007 and low productivity districts declined from 25 percent to 17 percent during the same period. On the other hand, the proportion of very high productivity districts increased from 11 per cent in TE 1991 to 23 per cent in TE 2007. There was also a shift in districts across the growth categories during 1990s and 2000s. During 1990s, about 60 per cent of the districts recorded low growth of less than 2.5 percent and 21 per cent of the
districts recorded high growth rate of more than 3.5 per cent. During the 2000s, the number of high growth districts increased to 35 per cent. Modern inputs such as use of fertilizer, rainfall, irrigation, sources of irrigation, human resources and road connectivity were found to be critical determinants of enhancing agricultural productivity. The authors suggested for insurance to mitigate the consequences of persisting instability in agriculture, prudent management of rainfall water, need for regionally differentiated strategies for ensuring sustainable and inclusive agricultural growth in a state and consequently in the country due to varying performance of crop sector at the district, state and national level.

**Birthal et al (2014)** studied the patterns and sources of agricultural growth for 20 Indian states during 1980-1981 to 2009-2010. They recorded transformation of Indian agriculture from a cereal-based production system toward high-value crops during the 1990s but food security concerns resurfaced during the first decade of the 21st century, and the policy environment tilted in favour of cereal-based production systems, especially rice and wheat. The authors concluded that technological change and diversification toward HYVs were the major sources of agriculture growth and to sustain this growth, investment in agricultural research must be increased, agricultural research agenda must be revisited in view of the emerging challenges and market opportunities in agriculture and the agrifood industry, irrigated facilities should be enhanced, formulation of policies, development of institutions, and infrastructure that facilitate farmers’ access to remunerative markets should be initiated.

**Chaterjee (2014)** analyzed convergence in per capita income in agriculture and identified the drivers of agriculture growth across 17 major states in India during 1967 to 2010 sub dividing the period into 1st sub phase (1967-1977) the period of green revolution, 2nd sub phase (1978-1989) period of falling public investment in agriculture and 3rd sub phase (1990-2010) period of economic reforms. The results of sigma test found that except in phase 1 when the standard deviation declined, there was no evidence of any trend in sigma convergence in any of the other sub-periods over the entire period. And further for spatial convergence analysis, strong evidence of spatial beta convergence in the entire period as well as all the three sub-phases was found. Factors that significantly drive agriculture growth were input usage, physical infrastructure and cropping pattern. However, input usage and infrastructure were significant only in the first phase. In the second and third phases, inputs were not significant but literacy was significant. Land, irrigation, rainfall and spatial variables recorded significant impact on growth during all the phases. Therefore, the author suggested for economic policy measures targeting improvement and expansion of infrastructural support, literacy input
usage and water management to promote long run agriculture growth and convergence across Indian states.

**Kumar, Lala and Chaudhry (2014)** examined convergence of per hectare Net State Domestic Product agriculture and catch-up among 15 Indian states during pre-WTO, post-WTO, and overall period during 1980-81 to 2000-01. The authors found that growth in NSDP agriculture during post reform period favoured agriculturally underdeveloped states whereas agriculturally developed states recorded deceleration. They concluded that the economic reforms initiated by government led to convergence in per hectare NSDP across Indian states whereas there was divergence during pre reform period. According to the authors, fertilizers, public finance, small holdings, cropping pattern, investment in agricultural research and education, physical infrastructure, mechanization and diversification were the main factors that led to convergence in agriculture growth and while framing policy and designing development programmes all these variables should be included as policy inputs for getting desired policy outcome.

### 2.3. State level studies

**Etienne (1968)** analyzed the factors influencing agricultural production in two districts- Bulandshahr, primarily wheat producing district, and Varanasi producing both wheat and rice crops in Uttar Pradesh. The author found that the state accounts for 19 per cent of the total agricultural area in India but it shares only 9 per cent of irrigation and allotted only 14.6 per cent of funds. The problems of corruption and lack of coordination in the administration machinery of the state were some of the causes of slow growth of agriculture. He further noted that the Intensive Area Cultivation Programme and use of new high yield Mexican wheat seeds had encouraging results on production and productivity in the state agriculture.

**Singh, Sirohi and Singh (1973)** fitted the Cobb-Douglas production function to the data on 40 farms of two villages of Meerut district of Western Uttar Pradesh for the year 1967-68 and examined the efficiency of farm resources among different crops grown on the farm. The variable Y (the dependant variable) showing yield per acre was regressed on human labour, bullock labour, manure and fertilizer expenditure and irrigation representing independent variables. Bullock labour turned out to be non-significant, whereas, the coefficient of manure and fertilizer and irrigation were significant in all the cases. For the optimum use, the authors suggested that resources should be diverted to irrigation which had maximum return per rupee of additional investment.
Singh (1975) fitted the Cobb-Douglas production function on the data on 150 farms in Deoria district of Eastern Uttar Pradesh for 1967-68 and worked out elasticity of output with respect to land, human factor, bullock labour, manures and fertilizer and fixed capital. The value of $R^2$ was 0.86 and the sum of elasticities was equal to one, establishing the constant returns to scale in agriculture of Eastern Uttar Pradesh. The ratio of marginal value product to factor cost indicated that all factors except land were being used at the optimal level.

Shaffi (1984) examined agricultural productivity and regional imbalances in the Uttar Pradesh agriculture. The analysis was based on data for 13 main crops (wheat, rice, jowar, bajra, maize, pigeon pea gram, green gram, black gram, bengal gram, ground nut, sugarcane, and potatoes) for 48 districts during 1966-67 to 1975-76. The author compared the inter-district variations in productivity by employing seven alternative methods of productivity measurements and found that the standard nutrition value unit (SNU) output per hectare method was most suitable. By employing the factor analysis and Cobb-Douglas type of production function, irrigation by canals, irrigation by other sources, chemical (NPK) fertilizer consumed and number of agricultural workers in a district had significant relationship with inter-district differentials in productivity. The first three were positively associated with productivity, whereas the last had negative association with it.

Singh and Saxena (1985) assessed agricultural development in Uttar Pradesh from 1960-61 to 1980-81. Authors found that the food grains production during this period recorded a significant high growth (3.61 per cent per annum) and exceeded the population growth (2.51 per cent per annum) in the state. The authors concluded that if this trend in agriculture growth is maintained and population is controlled, production in 1990-91 and 2000-01 was predicted to be 29.9 million tonnes (MT) and 34.9 million tonnes respectively and the state would be food surplus at the end of century. Provision of incentive support prices, declaration support before sowing season, organizational support for the purchase of commodities at support prices and a timely, easy and adequate supply of essential inputs were recommended by the authors to help and promote agricultural development in the state.

Chopra (1986) compared the agricultural development in Uttar Pradesh and Bihar with agriculturally leading states of Punjab and Haryana. He noted that the state economy was basically an agrarian in nature and marked by small sized holdings and low level of development. Value of agricultural output of food grains and main commercial crops in 1977-78 was Rs 573 per hectare in Uttar Pradesh compared with Rs 1779 in Punjab and Rs 1172 in
Haryana. The author concluded that the problems responsible for low productivity of agriculture were non-implementation of land reforms, predominance of small sized holdings and underdeveloped and underutilized irrigation facilities in the state. He suggested for rural electrification, diversification from food and cash crops and development of irrigation in the state for agricultural development and the state should be split up into three-four independent units for its better administration and overall development.

Jain (1990) analyzed the correlation of wheat and rice yield with the introduction of the high yielding variety seeds across 44 districts for the pre HYVs period (1954-55 to 1965-66) and the HYVs period (1966-67 to 1980-81) in Uttar Pradesh. The author found that number of significantly positive correlations between actual yields for wheat increased in all the cases, with highest increase in the Western region. The actual yields of rice also showed an increased number of significantly positive correlations. However between the districts of the Eastern and Bundelkhand regions, actual yield correlations of rice became less significant during the second period. The inter-district correlations for yield variability for wheat and rice recorded that the number of significantly positive correlations between districts decreased during the second period in all the regions. The inter-district correlations between the districts of the different regions showed significantly positive correlations during the HYVs period compared to the first. Whereas, the number of negative correlations between the districts of these regions was greater during the period of HYVs as compared to the first period, for both wheat and rice crops.

Arora, Srivastava and Bhogal (1997) analyzed the agricultural growth in area, production and productivity for wheat, paddy, sugarcane, potato, oilseeds and pulses for five economic regions- Western, Central, Eastern, Bundelkhand and Hills in Uttar Pradesh. The study covered the period from 1970-71 to 1993-94, dividing it further into two sub periods, 1970-71 to 1979-80 and 1980-81 to 1993-94. The authors found that the state performed much better (4.99 percent) as compared to the nation (1.87 percent) in wheat in 1970s in area, production as well as productivity. Among the regions, the Eastern region outperformed other regions in the state. However the second period recorded deceleration in wheat growth rates. In case of paddy, oilseeds and sugarcane, the growth rates in production and productivity in 1970s were found to be non significant but in the second period, the state outperformed the country as a whole in terms of growth in production as well productivity. The performance with respect to pulses was not found to be significant in both the periods. The state did well during the first period in the case of potato but there was deceleration in the growth in area as
well as production during the second period. The authors concluded that irrigation facilities and use of chemical fertilizers contributed to the variations in crop productivity in the state.

**Kumar (2000)** examined the levels of input utilization and spatial behavior in the agriculture pursuit, measured the level of agriculture development and the extent of agriculture land potentiality in the development of agriculture and suggested the ways to reduce inequalities and raise the level of agriculture development in Uttar Pradesh. The study was based on the district level data for triennium 1980-83 excluding the hill districts because of non-availability of data. The method of principal component analysis was used to measure the levels of agriculture development and to derive the component responsible for disparities in the levels of development. A set of 11 variables was grouped into two segments a) input utilization, b) related to agricultural land potentiality. Author found out that the districts in the Western regions were highly developed whereas those in the Eastern parts had very low level of development. The inter-regional differences were mainly due to availability of irrigation facilities and use of modern agricultural inputs.

**Shukla (2002)** examined the constraints for slow growth rate of agriculture in Uttar Pradesh and suggested strategies and policies for higher growth rates. The author found that agriculture growth was about 2.7 percent per annum during 2001 which was slower than the other sectors growth rates. There were widespread induced fluctuations in agricultural production and growth. These fluctuations were partly weather induced and partly institutional led. There was lack of diversification in agriculture from low value crops, inadequate and inefficient infrastructure for development, the non-economic holdings were dominated in the state that could neither face the challenging position nor get benefits from liberalisation. Therefore, the author suggested for a need for a new mode of organizing agriculture and production, processing and marketing into a single system.

**Srivastava (2003)** analyzed the temporal changes in the cropping pattern of paddy, maize, bajra, wheat, potato and sugarcane in the Western region of Uttar Pradesh during 1950-51 to 2000-01, for pre liberalization and post liberalization periods. The pre liberalization period was grouped into three sub periods: Pre-green revolution phase (1950-51 to 1966-67), green revolution phase I: 1967-68 to 1979-80 and green revolution phase II: 1980-81 to 1994-95. The author found that the technological breakthrough brought by the green revolution led by liberalization in the early 1990s led to a sharp increase in the share of paddy, maize, wheat and potato area by the triennium 1966-68 compared to 1950-52. The introduction of high
yielding variety of paddy and wheat along with other improved package of practices provided
the incentives to the farmers to bring land improvement and irrigation facilities which led to
increase in the cropping intensity in the Western Uttar Pradesh. The findings of the study also
indicated a bias of the green revolution associated technological breakthrough and
liberalization against the coarse cereals in the state.

**Bajpai and Volavka (2005)** identified and analyzed the issues and problems associated with
the agriculture sector in Uttar Pradesh since pre-green revolution period from the early
1960’s. The authors examined the growth of agricultural outputs during green revolution in
Uttar Pradesh and those in relation to Punjab and Haryana and also examined intra-state
variations in patterns of agriculture between Western and Eastern Uttar Pradesh. The most
significant variables were fertilizers, high yielding variety seeds, rainfall, irrigation, soil
fertility, size of holdings and size of markets that explained the differential agricultural
performance of Uttar Pradesh relative to Punjab and Haryana. During the green revolution
period, only the Western region of Uttar Pradesh made good use of high yielding variety
seeds relative to other parts of the state. Overtime, Eastern Uttar Pradesh made strides to
narrow the gap with its Western counterpart. However, disparities between the two regions
persisted. The authors suggested increased focus on irrigation, research and development,
infrastructure, promotion of agro-based industries and adoption of new technology as the
areas that required higher public investment and government attention for growth of
agriculture in the state.

**Rehman, Wahab and Asif (2008)** examined variations in crop productivity in Ganga-
Yamuna Doab in Uttar Pradesh. Using Yang’s ‘Crop Productivity Index’, the authors
examined the crop productivity variations of 13 major crops grown in the districts of the
region and the changes in productivity during 1990-94 and 2000-04. The analysis found that
during the period of 1990-94, there were only four districts with low productivity, while
during the period 2000-04, the number of districts increased to nine. There were variations in
productivity influenced by the physical and socio-economic factors, substantial variation in
respect of soil fertility, preponderance of small and semi-medium holdings and highly
fragmented fields which showed low yields in farming areas. To increase the productivity of
crops per hectare, the authors suggested for application of new agricultural technology
brought with high-yielding varieties, dividing the Doab into a number of micro agro-climatic
zones and intensive efforts to be made to evolve new high-yielding varieties suiting to each
agro-climatic zone.
**Prabha, Goswami and Chatterjee (2010)** estimated rural poverty across 48 districts in Uttar Pradesh to measure and analyze the regional and district level variations in the incidence, depth and severity of rural poverty and to examine the linkage between agricultural productivity and incidence, depth and severity of rural poverty across the districts of the state. The authors estimated rural poverty for four quinquennial years based on National Sample Survey Organization data for the 43rd (1987-88), 50th (1993-94), 55th (1999-2000) and 61st (2004-2005) rounds of Household Consumption Expenditure Survey reports. The authors found significant differences in the incidence, depth and severity of rural poverty across the regions and districts of Uttar Pradesh. Rural poverty was recorded high across the districts in comparison to national average. The linkage between agricultural productivity and rural poverty was found to be significant at the district level. The authors suggested that to alleviate poverty in the rural areas of the state, the state government should make a sincere effort to improve the agricultural productivity in the districts of the state. Neglect of agriculture will hamper the growth of industries, particularly agro-based industries and weaken the macroeconomic fundamentals of the state and the country as a whole.

**Pandey and Reddy (2012)** analyzed the agricultural productivity levels and variations in productivity for 70 districts and four regions in Uttar Pradesh during 2005-06 to 2007-08, to identify the factors that affect land and labour productivity and in turn, rural poverty in the state. The authors found that the performance of agriculture in Uttar Pradesh varied considerably across districts and regions and has strong linkages and implications for poverty reduction. Irrigation and fertilizer-use were found to be the major determinants of the level and variations of agricultural productivity in the state. Econometric analysis indicated that an increase of 10 per cent in land productivity would reduce poverty by 4.3 per cent. The dependence of workers on agriculture recorded inverse relationship and 10 per cent reduction in labour force could result in 7.7 per cent reduction in poverty. The authors suggested the need for strengthening the non-farm employment and income opportunities along with improved farm productivity through resource diversification towards high-value crops like fruits and vegetables in low productivity districts and region-specific development strategies of generating non-farm activities along with improving land productivity for reducing rural poverty in Uttar Pradesh. They also stressed on the need for public investment in irrigation and incentives to encourage agricultural diversification and intensive-use of inputs like fertilizers in the state.
Raman and Kumari (2012) analyzed district and regional level disparities in agriculture development in Uttar Pradesh. The study was conducted for 54 districts using 13 agricultural development indicators for two cross-section years 1990-91 and 2008-09. The authors found that the development of agriculture in Uttar Pradesh was polarized in Western region followed by Central region and Bundelkhand region was the least developed. The maximum number of developed districts was also recorded in agriculturally commercialized and technologically advanced Western and Central regions of the state. Western region was found to be much influenced to green and technical revolution that led to high contribution in export and food production of the state. The authors therefore suggested that to alleviate the problem of high and alarming disparity in agriculture development there should be region specific policies, specially for low developed Bundelkhand and high density Eastern regions, availability of credit and subsidy to the neediest region and need to identify the agro-climatic zones that have problems and are most backward such as Bundelkhand and Vindhyan Zone and therefore specific efforts should be made for these regions.

Goyal and Kumar (2013) studied overall production trends of agriculture in Uttar Pradesh during 1950-51 to 2011-12 and cropping pattern in the state for the period 1982-83, 1991-92 and 1999-2000. The authors recorded an increase in agriculture productivity along with improved cropping pattern and state agricultural growth rates were found to be more satisfactory than national averages. The authors suggested that huge quantities of water could be saved by diversification of cropping pattern from rice, wheat and sugarcane crops to less water consuming crops and in addition technological improvement and change in the agricultural practices in general and irrigation practices, in particular, could also help to reduce the water consumption in these crops.

Shafiquallah (2013) analyzed the spatial pattern of regional disparities, variations in the levels of agricultural development and relationship between agricultural development and 14 agriculture indicators during 2001. The spatial distribution of agricultural development recorded that majority of North-Eastern and Southern districts in the state were backward and districts from Western and Central plain regions had higher levels of development. In the analysis of level of regional disparities the author found that tarai districts were backward whereas Western, Central and Southern districts were in favourable position. The relationship between levels of regional disparities recorded an increase from West to Central and Eastern region. The author concluded that the state has tremendous scope for agricultural development and social justice and balanced development can be achieved through increased irrigation facilities and giving top priority to low developed regions and districts.
Table 2.1: Key features and findings of main district level studies in India

<table>
<thead>
<tr>
<th>Author</th>
<th>Objective of the study</th>
<th>Period</th>
<th>Districts included</th>
<th>Crops covered</th>
<th>Main Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown (1971)</td>
<td>Impact of IADP programme</td>
<td>1956-57 to 1965-66</td>
<td>320</td>
<td>19 crops</td>
<td>No significant difference in performance of IADP with non IADP districts</td>
</tr>
<tr>
<td>Gordan (1974)</td>
<td>Inter-district disparities and their causes</td>
<td>1960-61</td>
<td>Districts in 16 states</td>
<td>12 crops</td>
<td>Irrigation leads to higher yield, education imp. than health for human capital formation and output/acre was large on small farms.</td>
</tr>
<tr>
<td>Bhalla and Alagh (1979)</td>
<td>Inter-district variations in agricultural performance and sources of growth</td>
<td>1962-65 to 1970-73</td>
<td>282</td>
<td>19 crops</td>
<td>69 high prod., 130 mid &amp; 83 low prod. districts, 50 districts recorded gr. &gt; 4.5 %, 105 (1.5-4.5%) &amp; 62 (0.5 to 1.5%), districts in Eastern UP, Bihar and WB recorded low growth rates, modern inputs and irrigation led to inter-district disparities.</td>
</tr>
<tr>
<td>Chand, Garg and Pandey (2009)</td>
<td>Regional variations in agriculture productivity and its linkage with poverty</td>
<td>2003-04 and 2004-05</td>
<td>551</td>
<td>45 crops</td>
<td>191 districts recorded low and 66 districts recorded very low productivity, 1% increase in rainfall leads to 0.43% increase in prod, fertilizer (0.27%) and irrigation (0.11%). 1% incr. in land prod. reduces poverty by 0.51%. and 1% reduction in labour force leads to 0.49% decline in poverty.</td>
</tr>
<tr>
<td>Bhalla and Singh (2012)</td>
<td>Economic Liberalization and Agricultural Performance</td>
<td>1962-65 to 2005-09</td>
<td>281</td>
<td>44 crops</td>
<td>Economic liberalization led to decline in agriculture performance at the state as well as district level, except Gujarat and Maharashtra, all other states faced reverses in agriculture growth.</td>
</tr>
<tr>
<td>Kumar and Jain (2013)</td>
<td>Trends, instability &amp; drivers of agriculture productivity</td>
<td>1990-91 to 2007-08</td>
<td>388</td>
<td>45 crops</td>
<td>Increase in high growth districts in 2000s. The elasticity of cropping intensity was 1.17, followed by fertilizer use (0.29), irrigation (0.20), literacy (0.19), rainfall (0.17), road density (0.11) and credit (0.0003).</td>
</tr>
</tbody>
</table>
Table 2.2: Key features and findings of main district level studies in Uttar Pradesh

<table>
<thead>
<tr>
<th>Author</th>
<th>Objectives</th>
<th>Period</th>
<th>Districts included</th>
<th>Crops covered</th>
<th>Main Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kumar (2000)</td>
<td>Analyze pattern of agriculture development and inputs used</td>
<td>1980-83</td>
<td>48</td>
<td>11 variables</td>
<td>Districts in Western region high developed and low in Eastern region and irrigation and modern inputs lead to inter-district disparities in agriculture.</td>
</tr>
<tr>
<td>Pandey and Reddy (2012)</td>
<td>Linkage b/w farm productivity and rural poverty</td>
<td>2005-06 to 2007-08</td>
<td>70</td>
<td>Not mentioned</td>
<td>1% increase /decrease in agricultural productivity leads to 0.43% increase/decrease in rural poverty</td>
</tr>
<tr>
<td>Raman and Kumari (2012)</td>
<td>Inter-district disparities in agriculture development</td>
<td>1990-91 and 2008-09</td>
<td>54</td>
<td>Only Food grain crops included for agriculture development and 13 indicators of development</td>
<td>Western and Central regions high developed, Bundelkhand low developed and all development indicators except road highest in western region</td>
</tr>
<tr>
<td>Shafiullah (2013)</td>
<td>Inter-district disparities in agriculture development</td>
<td>2001</td>
<td>70</td>
<td>14 indicators of agriculture development And 26 to measure inter-district disparity</td>
<td>Marked disparities from west to central and eastern regions, literacy, urbanization, health, education and infrastructure significant in inter-district disparities.</td>
</tr>
</tbody>
</table>

2.4. Conclusions

2.4 (i) From International studies:

1. There is a shift from the traditional to modern agriculture due to availability of modern inputs, technological developments, research and extension in the agriculture sector.
2. There are wide inter-country, intra-country disparities in agricultural performance due to agro-climatic, infrastructure, human capital as well as technological differences.
3. Reforms in agriculture sector have contributed to better agricultural performance in the developing countries. China however reaped the maximum benefits.
4. Signs of conditional convergence among some Asian countries. However there is neither convergence nor divergence in regional disparities in the countries like China.
5. Need to formulate policies to focus on agriculture research and development, development of HYV seeds, establish bio-technology programs, etc.
6. Growth in area effect and yield effect are major source of output growth. However due to limitation on area expansion there should be more emphasis to yield augmenting technological changes.

2.4 (ii) From National level studies:

1. The Green Revolution technology introduced in mid sixties was mainly confined to irrigated North-Western regions of Punjab, Haryana and Western Uttar Pradesh and to some pockets in Coastal regions. Initially it almost bypassed major areas in Eastern, Central and Southern regions.
2. During initial phase, Green Revolution led to widening of regional disparities in Indian agriculture.
3. Indian agriculture experienced diversification from low technology and low value coarse cereal crops and pulses towards better technology crops rice and wheat, and high value commercial crops like plantation, fruits and vegetables, condiments and spices crops.
4. With the passage of time, new technology spread to newer areas and encompassed more districts, leading to widespread gains across all regions.
5. There was deceleration in the agriculture growth rates after the reform in almost all the states except Gujarat and Maharashtra. The post-reform performance of agriculture was contrary to the expectations.
6. There is shift in the sources of agriculture growth from traditional inputs like land, labour and animal capital to modern industrial sector inputs such as machinery, chemicals, pesticides, new seeds etc.
7. Development of infrastructure and institutional changes contributed immensely to agricultural performance in India.
8. Decline in public sector investment led to slow down in agricultural growth during the reform period.
9. There exist wide regional, district as well as state level disparities due to variations in natural, human and infrastructure facilities.
10. There are some signs of convergence in agriculture growth during shorter time period, however during longer time periods states with higher crop area under irrigation
converged to higher growth rates and states with low area under irrigation converged to lower growth rates.

11. Yield effect played an important role in output growth in Indian agriculture.

2.4 (iii) From State level studies for Uttar Pradesh:

1. Different studies for Uttar Pradesh cover different number of crops.

2. Most of the state level studies are confined to limited period of almost two decades.

3. Most of the studies have limited objectives. Therefore many of the issues like growth dynamics, labour productivity, convergence/divergence and other spatial dimensions are ignored by most of the researchers.

4. Most of the studies focused on identification of sources of growth and regional differentials in agricultural performance lack sophisticated econometric analysis to arrive at more definite conclusions.

2.5. Gap in literature

1. There is no recent comprehensive district level analysis of agricultural performance for Uttar Pradesh.

2. Majority of the studies analyzing agricultural performance are on basis of initial and end trienniums averages. This sometimes leads to erroneous estimation of growth in case any of the trienniums contains abnormal production years. Such analysis ignores well known year-to-year fluctuations in agricultural production.

3. The intra-state analysis of agricultural performance below state levels are few and are far between.

4. A comprehensive analysis of district level agriculture in Uttar Pradesh in post reform period is not available.

5. Most of the studies are confined to analysis of inter-regional variations in agricultural development in Uttar Pradesh. Much literature is not available on whether these regions or districts are coming closer or moving far away in the process of agriculture growth and
development in the state. We could not lay our hands in any study analyzing the process of convergence or divergence in performance of agriculture in Uttar Pradesh.

6. With a few exceptions, most of the studies identifying sources of agricultural growth are weak on methodological account. The problems of heteroscedasticity and multicollinearity are ignored by researchers, which lead to misleading conclusions. Furthermore, the idiosyncratic factors which play significant role in agriculture sector are ignored by the researchers.

7. We did not come across any study analyzing the district or region wise growth and level of agricultural workers productivity in Uttar Pradesh.