Chapter 1

INTRODUCTION

This chapter presents the background and motivating interest of undertaking this research and emphasises the appropriateness of this dissertation in the emerging agribusiness system. It critically reviews the growth performance of Indian agriculture since independence and briefly discusses the twists and turns during various plan periods. Further, it describes the problem statement in terms of major risks and challenges being faced by Indian agriculture in its transition and structural change in the twenty-first century. In addition, this chapter describes the detailed objectives, research questions, and the structure of this dissertation.

1.1 Background

Historically, agriculture has been the backbone of many economies including India. The post-independence period marks a turning point in the history of Indian agriculture, which is clear from the fact that compared with annual growth rate of less than 0.5 percent during pre-independence period (1904-05 to 1945-46) the agricultural sector recorded an annual growth rate of 2.8 percent during 1950-51 to 2011-12 (CSO, 2012; Bhalla, 2008). Though its contribution to the overall Gross Domestic Product (GDP) of Indian economy has fallen from 55 percent in 1950-51 to less than 15 percent in 2011-12, a trend that is expected in the development process of any economy (as experiences from elsewhere in the world shows), the sector’s importance in economic and social fabric goes well beyond this indicator. Still, this sector employs more than 50 percent of India’s workforce and accounts for about 10 percent of export earnings (Sharma, 2011). It is critical source of livelihood of the vast majority of rural population particularly small-scale farmers, who constitute the majority of farming population i.e. more than 70% of the country population (Chand et al., 2011; World Development Report, 2008; Vyas, 2003). Agriculture is a dynamic in nature and evolved over the time and will continue to change in future as well (Saxowsky and Duncan, 2008).

1The term agriculture is derived from the latin words ager or agric meaning soils and cultura means cultivation. Agriculture is the art, science and business of crop production. It encompasses all aspects of crop production, livestock farming, fishery and forestry.
After the independence, the status of Indian agriculture has improved by leaps and bounds with advancements in production technologies as well as supportive policy measures. The high degree of targeted government interventions in the agricultural sector since the beginning of the first Five Year Plan (1950) and the late 1960s revolution so-called “Green Revolution” have transformed the country from a “begging bowl” image to “agricultural powerhouse”. This has enabled a successful transition in Indian agriculture from its stagnation to a growth path. Now, the country is the world’s largest producer of milk, second largest producer of horticultural commodities (fruits & vegetables), third largest producer of food grains, fifth largest producer of eggs and ninth largest producer of poultry meat in the world, and is second only to China in terms of overall food production (Bhaskarachary, 2009; Singh, 2008; Birthal et al., 2005). The pivotal importance of agriculture in the country was recognized for ensuring food & nutritional security to its population of more than 1 billion and also for alleviation of poverty in the country (Kumar and Nath, 2010).

Despite this domination, the agriculture sector, however, could not maintain its growth momentum in the 1990s after the initiation of economic reforms. The strategic growth in agriculture and the accelerated growth in industry reversed the structure of national GDP in Indian economy. The process of economic liberalization and privatization policies in the country has witnessed significantly higher economic growth at the start of 21st century but it failed to improve agricultural status (MSSRF, 2008). The country’s overall GDP increased from 5.8 percent per annum during 1990-2000 to a peak 7.3 percent during 2001-2012. However, during the same period, agricultural GDP decelerated from an average 3.2 percent to 2.9 percent per annum (Central Statistics Office-CSO, 2012). Declining performance of the sector in terms of its growth has been one of the major concerns facing policy makers and the scholars having interests in the sector. The slackened performance of agriculture may be attributed to decline in public investment in agriculture from 5 percent of agricultural GDP in 1980-81 to 3 percent in 2006-07 (TASS & IFPRI, 2009). Agricultural growth has always been a crucial component for inclusiveness; however, high GDP growth without high agricultural growth is likely to lead to acceleration in inflation, which would adversely affect the larger growth process in the country (GoI, 2011).

2The experience from BRICS countries indicates that a one percentage growth in agriculture is at least two to three times more effective in reducing poverty than the same growth emanating from non-agriculture sectors.
Slow agricultural growth is a matter of great concern as majority of India’s rural population is directly/indirectly dependent on agriculture for earning their livelihood. Performance of Indian agriculture also decelerated in terms of growth rate of crop yields as well as total agricultural output during the 1990s (Sharma, 2011). In addition, the share of agricultural exports in total export value declined from about 18.5 percent in 1990-91 to about 10.5 percent in 2010-11, while share of agricultural imports to total national imports increased from 2.8 percent in 1990-91 to about 3.5 percent in 2010-11 (Gol, 2011; Sharma, 2011). The all round failure to achieve sustained growth in agriculture has resulted from the potential risk and challenges facing agriculture in the 21st century (Ghorbani and Jafari, 2009; Wenner, 2005). The agriculture sector which is characterised by high exposure to risk is becoming an ever riskier over the years. Recent researches has observed that there is rising intensity, complexity, frequency and duration of agricultural risks of all kinds – climatic (hail, drought, flood, landsides, frost, tornados, hurricanes, heat waves, and storm surges), biological (diseases and insect infestations), geological (earthquakes, and tsunamis), market (price variability), and man-made (financial crisis, collapse of legal institutions) – impacting adversely the agriculture as a whole (Viswanathan et al., 2012; Ali and Kapoor, 2009). Besides, farming community, particularly the smallholders, faces several challenges arising from a range of socio-economic, demographic, structural and institutional factors that adversely affect its sustainability and livelihood (Viswanathan et al., 2012; World Bank, 2007).

Over a period of time, Indian agriculture is undergoing a major transformation with a shift in production, consumption and trade from foodgrains towards high-value agricultural commodities (IFPRI, 2011; Birthal and Joshi, 2006; Gulati et al., 2005). The relative importance of grains and staple foods are declining while that of high value agriculture such as fruits, vegetables, milk, meat and eggs are significantly increasing as a share in agricultural output (Chand and Raju, 2008; Gulati et al., 2007). As evident from the fact that, the share of high-value commodities/products (fruits and vegetables, livestock products, fisheries) increased from 37.3 percent in TE 1983-84 to 47.4 percent

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3As opposed to traditional commodities, high value agricultural products have relatively high unit values and a high income elasticity of demand. Typically, high value agricultural products may have higher value-to-weight ratios than high volume commodities. In addition, they are rather labour-intensive, require high food safety and quality specifications, and need to be integrated in a well-coordinated supply-chain (http://www.rfpp.ethz.ch). For example, a crop, fish, livestock or non-timber forest product that returns a higher gross margin per unit of available resources (land, labour, capital, human capacities) than other products within a given location and context, may be considered as high value items.
in TE 2007-08 (Sharma and Jain, 2011). The structural change was largely driven by rapidly changing demand for high value food due to rising incomes, urbanisation and lifestyle changes (Birthal and Joshi, 2006). Also, the share of high value commodities in agricultural trade has been increasing over the decades (Sharma and Jain, 2011). The growth of high value agriculture presents both opportunities and challenges to various stakeholders in agricultural system. On a brighter side, new opportunities are unfolding in the form of increasing demand for high-value commodities in the domestic and global markets, which is pointing out towards the potential prosperity that can be brought into the farm sector (IFAD, 2011).

The entry of corporate sector and MNCs in developing countries with innovative business strategies of market-driven technologies, contract farming, processing of agri-products, developing organized retailing and exploring markets for exports is providing a new dimension to the Indian agriculture. At the same time, the changes are posing serious challenges, particularly, to small scale farmers on how to involve them in the capitalizing markets and ensuring the share of benefits arising from the new opportunities (Swinnen, 2007). The main challenges towards the small farmers, in the process of moving towards high value agriculture are high cost of production, insufficient technical knowledge of cultivation & plant protection, declining productivity, inadequate access to financial & extension services, improper post-harvest practice & poor handling, inadequate infrastructure and lack of storage and cold chain facilities, low bargaining power, problems of aggregation & transport costs, increasing agri-waste, growing marketing inefficiencies & lack of market information, poor governance & non-supportive policy, environmental constraints including those arising out of climate change. In addition to these, as the most of high value agricultural products are comparatively perishable in nature, it requires greater coordination in the way the food is produced, processed, marketed and consumed (Deshingkar et al, 2003; Busch and Bain, 2004; Henson and Reardon, 2005; Swinnen and Maertens, 2007).

Given the potential risks and challenges, agricultural growth in the country must increasingly rely on sustained and improved productivity growth through continued technological and institutional innovations. The agricultural improvements must be seen in an integrated view of supply chain and appropriate interventions need to be made on its weakest links to strengthen the chain for bringing efficiency and effectiveness. In the recent years, a number of interventions have been initiated by the
public and private sectors for improving the value chain linkages effectively managing the potential agricultural risk to tackle the emerging challenges and have thereby given a ray of hope to the farming community and the agriculture sector to move on a high growth trajectory so as to sustain high GDP growth.

1.2 Agricultural Growth Performance and Structural Change

Agriculture is the lifeline of more than 70 percent of India's population who are directly/indirectly dependent on agriculture for their livelihood (Census of India, 2011). Therefore, agricultural performance in the country is a determining factor in the quality of life of over 742.5 million people living in the rural areas. Pre-independence, agriculture was practiced on traditional lines, typically subsistence basis, where farmers raised most of their crops for their own consumption instead of for trade with negligible/little use of improved seeds, chemical fertilisers, pesticides, and farm machineries. Farm fields were small and scattered and farms were largely dependent on the rainfall for the irrigation. After independence, India has adopted a policy of planned agricultural development at varying stages with targeted interventions, embracing a wide variety of institutional and technological interventions to make the country self sufficient in food production. From the late 1960s onwards, the green revolution helped the sector maintain steady growth for more than two decades which enabled the country not to be food secure at national level but also to become food exporter to the world (Kumar and Nath, 2010).

Today, with 195 million hectares area under cultivation (63% rainfed & 37% irrigated), India is the world's second largest producer of food next to China, and has the potential of being the biggest in the world (MoA, 2001b). The foodgrains production (defined in India as cereals plus pulses), which largely determines the status of food security in the country, has touched a new peak of 241 million tonnes in 2010-11 from a mere 50.8 million tonnes in 1950-51; with an average growth rate of 3.2% per annum (Ministry of Agriculture Gul, 2012). Apart from food grains, the performance of high value crops and activities of allied agriculture - dairying, fishing, forestry - have shown significant growth in the recent decade. Known as fruit and vegetable basket of the world, India is the second largest producer of fruits and

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4However, the availability of food grains is not a sufficient condition to ensure food security to the poor also necessary that the poor have sufficient means to purchase food (Prahadeeswaran et al., 2005).
vegetables accounting for about 16% of global vegetables production and 10% of world fruits production. The country is also a front runner in many fruits and vegetables with highest share in world production i.e. bananas (31%), papayas (42%), mangoes (42%), green peas (36%), cauliflower (30%). Much of the credit for this success should go to the several million of marginal and small farmers that form the backbone of Indian agriculture and the economy.

However, high performance variability has been observed in the growth of agriculture GDP as compared to the overall GDP of the country (Figure 1.2a). The variability is particularly pronounced due to the vagaries of weather and dominancy of subsistence nature of farming. The high degree of variability also stems from the problem of declining yields of few crops. However, as the figure shows, the agriculture growth rate in India’s GDP had been growing earlier but in the last few years it is constantly declining.

Figure 1.2a: Comparative performance of growth of GDP (Overall) and GDP (Agri.) in India

![Graph showing comparative performance of growth of GDP (Overall) and GDP (Agri.) in India](image)

Source: Central Statistics Office (CSO)

Considering the high fluctuations in year-to-year growth in agricultural GDP, agriculture growth has been classified into seven phases (excluding twelve plan), for better understanding of growth phases in agriculture sector (Figure). As evident from the figure, the pre-green revolution period (1950-51 to 1967-68) observed an average agriculture GDP growth of 2.2 percent. The green revolution was kick-started during 1966-67 and the effects of adoption of modern technology and institutional reforms were started showing results after 1967-68 onwards. The green revolution period (1968-69 to 1980-81) marked a significant shift in technology transfer, adoption of higher yielding varieties and use of chemical fertilizers & pesticides including expanded
irrigated areas and improved access to institutional credit. It resulted as an improved growth rate of 2.4 percent during the green revolution. The subsequent period (1981-82 to 1990-91) is classified as the period of wider dissemination of technology maintained the growth momentum with superior growth rate at 3.5 percent. Several agricultural and rural development programmes such as IADP (Intensive Agriculture District Programme), IAAP (Intensive Agriculture Area Programme), ND (National Demonstration) and HYVP (High Yielding Varieties Programme) were launched to support the agriculture sector.

The early reform period (1991-92 to 1996-97) benefited largely from these initiatives and attained highest growth rate of 3.7 percent. Then, the deceleration of agricultural growth was started from ninth plan period onwards and a clear indication of slumping of the agricultural sector was visible till tenth plan. This slump is attributed as an outcome of substantial diversion of resources away from agriculture to other sectors of the economy. However, eleventh plan period (2007-08 to 2011-12) has recovered the growth to some extent and registered 3.2 percent growth rate. Nevertheless, it was far behind the targeted growth rate of 4 percent.

Figure 1.2b: Average overall and agriculture growth rate (%)
Table 1.2 presents the growth dynamics of production of major crops/crop groups during various phases. It is evident from the table that the growth performance of the crop sub-sector was impressive in the first three phases of growth. This sector registered an annual growth rate of 2.15 per cent during the pre-green revolution period, which further improved to 2.64 per cent and 3.11 per cent in the phases of green revolution and wider dissemination, respectively. In the initial years after the inception of planned development (First Five-Year Plan), agricultural policies primarily focused on expanding cultivated area, land reform, community development, and restructuring rural credit institutions. However, during Second and Third Five-Year Plans, the priority on agriculture was diluted, and as a consequence, the sub-sector witnessed a deceleration during early sixties leading to food shortages and dependency on import of huge quantities of foodgrains for meeting domestic food demand. In the late 1960s, with “green revolution” interventions, all the crops such as cereals, oilseeds, fruits and vegetables, and sugarcane grew at a rate of 2.0 to 3.9 percent per annum. Further, in the period of wider dissemination phase, cereals, sugarcane, oilseeds, and fruits and vegetables maintained its growth rate. Therefore, from the late 1960s onwards, the green revolution helped the sector to maintain steady growth for more than two decades till 1996-97. As observed from Table 1.2, the overall growth in crop sub-sector dipped to 1.51 per cent during post-reform period from 3.11 per cent during the period of wider dissemination. The deceleration was aided by a negative growth in cereals (-0.02%), pulses (-0.09%) and sugarcane (-1.34%) and a poor performance of oilseeds (0.52%). However, the period of recovery (2006-07 to 2009-10) has helped most of these crops to recover their past.

Table 1.2: Trend Growth rates in VOP of various sub-sectors of crops at 1999-00 prices, 1950-51 to 2009-10 (Percent/annum)

<table>
<thead>
<tr>
<th>Growth Phase</th>
<th>All Crops</th>
<th>Cereals</th>
<th>Pulses</th>
<th>Oilseeds</th>
<th>Fruits &amp; Vegetables</th>
<th>Sugarcane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Green Revolution (1950-51 to 1967-68)</td>
<td>2.15</td>
<td>2.65</td>
<td>0.36</td>
<td>2.21</td>
<td>2.56</td>
<td>3.8</td>
</tr>
<tr>
<td>Green Revolution (1968-69 to 1985-86)</td>
<td>2.64</td>
<td>2.85</td>
<td>0.75</td>
<td>2.02</td>
<td>3.91</td>
<td>2.19</td>
</tr>
<tr>
<td>Period of Wider Dissemination (1986-87 to 1996-97)</td>
<td>3.11</td>
<td>3.06</td>
<td>0.99</td>
<td>6.56</td>
<td>3.69</td>
<td>4.21</td>
</tr>
<tr>
<td>Post-Reforms (1997-98 to 2005-06)</td>
<td>1.51</td>
<td>-0.0</td>
<td>-0.1</td>
<td>0.52</td>
<td>2.67</td>
<td>-1.3</td>
</tr>
<tr>
<td>Recovery (2006-07 to 2009-10)</td>
<td>1.97</td>
<td>2.24</td>
<td>1.68</td>
<td>0.91</td>
<td>4.11</td>
<td>-1.2</td>
</tr>
</tbody>
</table>

Source: Chand and Parappurathu (2011)
The agriculture sector also experienced transition and structural changes in agricultural input and output including food basket diversification since the Independence. As evident from the fact that, the share of chemical fertilizers in the total value of inputs increased gradually over the time, from less than 1 per cent in 1950-51 to 18.5 percent in 2007-08 (at constant 1999-00 prices). At the same time, the share of organic manures declined from over 16 percent to just over 5 percent. Likewise, there is significant increase in the share of high value crops such as fruits and vegetables in total value of output from agriculture. The share of fruits and vegetables in the total value of agricultural output increased from 13.6 percent in TE 1993-94 to 16.9 percent TE 2007-08. Similarly, the share in total value of agricultural output for milk and meat also increased from 15.4 and 4.4 percent in TE 1993-94 to 17.4 and 4.5 percent in TE 2007-08 respectively (CSO, 2011). Also, the consumer food basket is getting diversified from traditionally cereals based items towards high-value foods such as fruits and vegetables, meat, milk etc. Rising incomes, increased urbanization and literacy, as well as improved infrastructure and closer ties to global trends fuelled by the information technology boom are driving increased consumer priority to high value food with greater concern on food quality and safety (FAO, 2003; Deininger and Sur, 2007).

1.3 Understanding Transition and Structural Shift towards High Value Agriculture

India is blessed with favourable climatic conditions for the production of a wide variety of crops. Cropping systems within country varies from regions to region due to different soil and climatic conditions across the regions and hence different agro-ecological setting. The Indian sub-continent has been divided into 20 agro-ecological zones which signify its diversified agricultural production from tropical and temperate crops. India has various types of soil ranging from the fertile alluvial of the Indo-Gangetic plains to the black and red soils of the Deccan Plateau. Indo-Gangetic Plain region comprising the states of Punjab, Haryana, plains of Uttar Pradesh, Bihar and plains of Jammu & Kashmir. The food systems in the Indo-Gangetic Plain are largely dependent on rice and wheat grown in rotation. Deccan Plateau covers parts of central and southern India. In the Deccan Plateau, genetic diversity is manifest in food crops like sorghum, millets, pigeonpea, chickpea, groundnut, sugarcane and mango. In the existing diverse agricultural landscapes, India has the potential to become 'food basket' of the world.
Realizing this, India paid considerable attention to the production of staple crops for food security, and to a few traditional export crops (coffee, cotton, cashew nuts and tea), as their means for economic growth and development. However, the progress was slow and patchy, largely due to traditional agricultural practices and research and development (R&D) and extension services were almost absent/ inadequately to gear the sector. There is significant shift towards high value agricultural production, consumption and trade pattern has been observed (CSO, 2011). The agriculture, which is the engine of growth and development, has been greatly influenced by the process of globalization, liberalization, mechanization, informationization, policy reform, urbanization and changing consumption behaviours has changed the structure of the Indian agriculture in the recent decades (Ali, 2007; Narayananmurthy, 2006; Kumar and Kumar, 2004; Murty, 2000; Ran, 2000). Globalization and trade liberalization bring in multinational companies (MNCs) into the local food retail sector through the establishment of “super-markets” with efficient supply chain management practices that emphasize high quality & safety standard with promotion of processed food. The economic reforms initiated in 90s however, did not include any specific package for agriculture rather it promoted for private investments (Dev, 2009).

The post-reform agricultural policies have largely promoted mechanization in the sector (Majumdar, 2006). Importantly, the advent of ICT has revolutionized the market information flows among the supply chain stakeholders including consumers (Arshad et al., 2006). Changing food consumption behaviors was observed as one of the major drivers of agricultural transformation (Timmer, 2007). Furthermore, increased urbanization has resulted in change in lifestyles and access to markets for various high value products both of which have increased the demand for fruits & vegetables, milk, eggs, meat, fish, and other high-value foods &processed foods (Reardon and Berdegué, 2002). The structural transformation can be considered as a defining characteristic of the development process (Syrquin, 2006).

1.3.1 Transition and Instability in Agricultural Production

Indian agriculture is passing through an era of transition from traditional to modern agriculture. The modernization is an agricultural transformation process of hybridization, mechanization, chemicalization, informationization and commercialization with profound changes in cropping pattern (Majumdar, 2006). The transformation process is characterized by application of high yielding seed varieties,
farm equipment & pump irrigation, use of chemical fertilizers, insecticides, pesticides, use of ICTs and agricultural credit (Mathur et al., 2006).

Traditionally, the agricultural food production in the country is largely dominated by foodgrains, which is comprised of wide range of crops like wheat, rice, coarse cereals and pulses. The last three decades have seen the total area under foodgrains declined by about 2.21 million hectares between TE 1992-93 and TE 2010-11 and this decline in area under foodgrains reduced the share of foodgrains in total cropped area from about 72 percent in TE 1993-93 to about 63 percent in TE 2010-11 (Table 1.3.1a). The decline in area under foodgrains resulted in increase in area under high value crops such as fruits and vegetables. Foodgrains production rose from 174.75 million tonnes in TE 1992-93 to 231.38 million tonnes in TE 2010-11, an increase by 20.06 million tonnes. Major gain in foodgrains production came mostly from rice and wheat crops. Fruit and vegetable production has increased more rapidly than that of foodgrains, largely due to increase in all sorts of area under crops and yield (Singh and Pal, 2010). However, during the same period, other important crops like pulses and coarse cereals experienced decline in their production mainly due to decrease in area. Yield was an important factor accounts for the growth in production of almost all the specified crops (except oilseeds) over the said period.

<table>
<thead>
<tr>
<th>Table 1.3.1a: Trends in area, production and productivity of major crops/crop groups: (TE 1992/93 to TE 2010/11)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area (million ha)</strong></td>
</tr>
<tr>
<td><strong>TE 1992-93</strong></td>
</tr>
<tr>
<td>Rice</td>
</tr>
<tr>
<td>Wheat</td>
</tr>
<tr>
<td>Cr. Cereals</td>
</tr>
<tr>
<td>Pulses</td>
</tr>
<tr>
<td>Foodgrains</td>
</tr>
<tr>
<td>Oilseeds</td>
</tr>
<tr>
<td>Sugarcane</td>
</tr>
<tr>
<td>Fruits</td>
</tr>
<tr>
<td>Vegetables</td>
</tr>
</tbody>
</table>

Source: Ministry of Agriculture, Gol

An instability analysis in area, production and yield of above crops was also carried out considering its direct/indirect affect on variability of farm income/income risk. Estimates of instability in area, production and productivity of foodgrains and non-foodgrain crops are presented in Table Table 1.3.1b. Coefficient of variation is a simple method for measuring instability. A high coefficient of variation implies high
instability. Instability was found lowest in area as compared to yield in almost all the crops except wheat and oilseeds. Variability in foodgrains production is substantially lower than the non-foodgrain crops. In the decade 2000s, the coefficients of variation (CVs) for production were estimated highest 19.8 percent for fruits, 19.7 percent for oilseeds, 17.4 percent for vegetables, and 13.5 percent for sugarcane.

Production instability in fruits and vegetables were almost triple than that in yield in 2000s. Several factors may be responsible for this instability in area, production and productivity of these crops, including the technology adoption, policy regime, natural hazards, seasonality and instability in national/international food markets (Murshid et al., 2009). It was found that adoption of new technology had increased instability in foodgrains and agricultural production in India (Chand and Raju, 2008). A major reason for instability in food production is high fluctuation in food prices (UNEP). Natural calamities such as floods and droughts are common phenomena in the country, they adverse impact of natural calamities on foodgrain production (Hossain, 1990).

Table 1.3.1b: Instability in area, production and yield of major crops (Coeff. of variation, %)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area 90s</th>
<th>Area 2000s</th>
<th>Production 90s</th>
<th>Production 2000s</th>
<th>Productivity 90s</th>
<th>Productivity 2000s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>2.4</td>
<td>3.4</td>
<td>6.8</td>
<td>8.6</td>
<td>4.7</td>
<td>6.8</td>
</tr>
<tr>
<td>Wheat</td>
<td>5.5</td>
<td>4.1</td>
<td>11.2</td>
<td>7.2</td>
<td>6.3</td>
<td>3.7</td>
</tr>
<tr>
<td>Coarse cereals</td>
<td>6.9</td>
<td>4.2</td>
<td>9.3</td>
<td>12.5</td>
<td>9.6</td>
<td>12.9</td>
</tr>
<tr>
<td>Pulses</td>
<td>4.1</td>
<td>5.2</td>
<td>6.9</td>
<td>10.5</td>
<td>6.2</td>
<td>6.3</td>
</tr>
<tr>
<td>Foodgrains</td>
<td>1.5</td>
<td>2.4</td>
<td>6.9</td>
<td>8.3</td>
<td>6.9</td>
<td>6.4</td>
</tr>
<tr>
<td>Oilseeds</td>
<td>3.5</td>
<td>9.5</td>
<td>9.7</td>
<td>19.3</td>
<td>8.2</td>
<td>13.2</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>6.9</td>
<td>10.4</td>
<td>9.6</td>
<td>13.5</td>
<td>4.1</td>
<td>4.5</td>
</tr>
<tr>
<td>Fruits</td>
<td>9.1</td>
<td>18.6</td>
<td>14.0</td>
<td>19.8</td>
<td>7.0</td>
<td>5.6</td>
</tr>
<tr>
<td>Vegetables</td>
<td>7.2</td>
<td>11.7</td>
<td>14.7</td>
<td>17.4</td>
<td>10.2</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Source: Ministry of Agriculture, GoI

1.3.2 Structural Shift towards High Value Agriculture

Over the year, the high-value agriculture is becoming increasingly important, both as a share in agricultural output and in the food basket (Chand and Raju, 2008). In the post liberalization period, the agriculture sector in India observed a clear shift in production, consumption and trade from foodgrains to high-value agricultural commodities such as fruits and vegetables, milk and milk products, meat, fish, and processed food products (Gulati et al., 2005). Figure 1.3.2 clearly reflects the increased share of high value crops in total value of output from agriculture accelerated in the post reforms period. The
share of fruits and vegetables in the total value of agricultural output increased from 13.6 percent in TE 1993-94 to 16.9 percent TE 2007-08. This has happened largely due to increase in area and marginal improvements in yield (Sharma and Jain, 2011).

Likewise, the share in total value of agricultural output for milk and meat also increased from 15.4 & 4.4 percent in TE 1993-94 to respectively 17.4 & 4.5 percent in TE 2007-08. According to latest estimates published in Annual Reports of Department of Animal Husbandry, Dairying & Fisheries (GoI)\(^5\), the value of output from livestock and fisheries sectors together at current prices was about 4,08,386 crore during 2009-10 (3,40,473 crore for livestock sector and 67,913 crore for fisheries) which is about 30% of the value of the output of 13,76,561 crore from total Agriculture & allied Sector. This increase is attributed to shifting production-mix to meet the growing demand for high value commodities.

Figure 1.3.2: Percentage share in value of output from agriculture sector

Source: CSO (2010)

1.3.3 Horticulture: High Value Driver for Emerging Agriculture

Horticulture is fast emerging as a major commercial venture and value driver in emerging agricultural landscape in India. Fruits and vegetables significantly contribute and dominate Indian horticulture occupying 66 percent of the area under horticultural cultivation and contributing to more than 90 percent of the total horticultural production. Recent trends indicate that horticulture has contributed significantly to the growth in agricultural production (Table 5.2a). While the production of fruits and

\(^{5}\)http://dahd.nic.in/dahd/WriteReadData/Annual%20Report%202010-11%20English.pdf
vegetables increased at a CAGR of 5.3 percent during the period 1996 to 2006, it was only 0.8 per cent for cereals (IVRI, 2011). The significance and importance of horticulture is evidenced by the fact that horticulture crops occupy only around 8 per cent of total cultivable area while contributing to around 25 per cent of agriculture GDP (Figure 1.3.3).

Figure 1.3.3: Contribution of horticulture to agriculture GDP (2005-06)

1.3.4 India: The Emerging Vegetable Basket of World

As a traditional giant country of vegetable production, India is the second largest producer of vegetables in the world after China and accounts for about 15% of the world’s production of vegetables. Around 8 million hectares of area is under vegetable cultivation, which is about 5.4% of the total area under cultivation in the country. Vegetables farming enable the achievement of high value agricultural production in the country, organized on a relatively small area. The vegetable production is also extremely beneficial in the context of nutrition, employment, and income generation (USAID, 2011). The diverse agro-climatic zones in the country make it possible to grow almost all varieties of fresh vegetables in the country. The major vegetables grown in India are potato, tomato, onion, brinjal, cabbage and, cauliflower which account for around 60 percent of the total vegetable production in the country. India is the second largest producer of vegetables (ranks next to China) and accounts for about
13.4% of the world’s production of vegetables and also occupies first position in the production of cauliflower, followed by second in onion and third in cabbage in the world (Kundu, 2012). According to National Horticulture Board (GoI), the current production level is over 133 million tonnes and the total area under vegetable cultivation is around 8 million hectares, which is about 3% of the total area under cultivation in the country.

Figure 1.3.4a portrays the trends in area, production and productivity of vegetables over the years in the country. In the past decade 2000s, area under vegetable in the country has shown continuous increasing trend reflecting the growing interest of farmers in vegetable cultivation. Over the period of last 10 years, the total area under vegetable crops increased from 6.25 million hectares in 2000-01 to 7.99 million hectares in 2009-10. Remarkable increase in vegetable production from 93.9 million tonnes in 2000-01 to a peaked production of 133.7 million tonnes in 2009-10 was recorded. The increase in vegetables production has been attributed to substantial public support, geared at diversifying the sector. Farm level technical and financial assistant through the mission mode programmes and schemes like National Horticulture Mission, Integrated Horticulture Development (Gujarat and Tamil Nadu), and Subsidy on Horticulture Production Inputs to Small Farmers (Himachal Pradesh) have attracted farmers to venture into vegetable production as a business (Ali, 2008; Nath and Ahmad, 2011).

However, the production trends also shown a recent slowdown periods 2007-08 (108.7 million tonnes) and 2008-09 (110.1 million tonnes). Studies have pointed to a number of production constraints that slowdown the production trends. These constraints included pests, lack of trained labour, irrigation water shortage, market accessibility, lack of capital, transport, drought, flood, shortage of land and inaccessibility of inputs, poor farm management and lack of training (Seleka, 1999; Obopile, 2008; Madisa et al., 2010a). The contribution of yield improvement in the production increase was relatively high compared to the contribution of expansion in area. In the said period, the yield observed fluctuating trends in the range of 13.8 – 16.7 tonnes/hectare. At the peak of yield (16.7 tonnes/hectares) in 2009-10, vegetable production also mounted at 133.7 million tonnes.

http://parb.punjab.gov.pk/pdfs/horticulture%20for%20the%20Poor.pdf
India is being blessed with the unique gift of nature of diverse climate and distinct seasons, making it possible to grow an array of vegetables number exceeding more than hundred types with highest share of potato (27%) followed by tomato (9%) and brinjal (9%) (Figure 1.3.4b). As evident from figure, potatoes are the leading vegetable crop in the country and its production trends determine the vegetable as well as horticulture trend in the country. In last one decade, there has been considerable increase in potato production from 24.5 million tonnes in 2001-02 to 42.3 million tonnes in 2010-11 (Figure 1.3.4c). Currently, Uttar Pradesh ranks first in the total production of vegetables in Indian states followed by West Bengal, Bihar, Orissa, Tamil Nadu and Karnataka.

Figure 1.3.4b: Production share of major vegetable crops in India (2009-10)

Source: IVRI (2011)
Figure 1.3.4c: Trends in potato production in India (in million tonnes)

Source: National Horticulture Board

1.3.5 Uttar Pradesh: The Vegetable Basket of India

Uttar Pradesh is the largest producer of vegetables with 16 percent contribution to the national production from about 13 percent area under vegetable cultivation in the country. It occupies first amongst Indian states in the production of peas (50%) and potatoes (35%). The other important vegetables grown in the state are cauliflower, tomato, brinjal, onion, okra, cabbage and cucurbits. In 2009-10, vegetables were cultivated in an area of 1.02 million hectares and accounted for 22.4 million tonnes of peaked production. Figure 1.3.5 exhibits that from the year 2001 onwards area under vegetables has been increasing that resulted into the constant increase in vegetable production. However, a downward trend in the year 2009 was also observed. This may be due to the fact that 30 percent dip in potato production in the leading state West Bengal in 2009 than the previous year on account of late blight. Regarding trend in yield, it was observed that it ranged between 18.1 – 22.0 tonnes/hectare, in the said duration.

Figure 1.3.5: Trends in area, production and productivity of vegetables in Uttar Pradesh
1.4 Emerging High Value Supply Chain Structure

Above discussion confirms that agri-food supply chains in the country are changing significantly with structural changes in production, trade and consumption pattern towards high value food products. Also, there is growing importance of quality and safety standards including vertical coordination and emergence of large modern food retail chains. A framework for understanding the changes in agri-food supply chains is presented in Figure 1.4a.

Figure 1.4a: Changes in agri-food supply chains in India

With above changes, the country is experiencing emergence of high-value & high-standards food supply chains such as horticulture, meat and dairy products, destined for high-income markets also targeting export to big international market. The high value chains are becoming more organized and standards with a move from arm’s-length market relations and spot-market transactions towards more explicit forms of coordination in the chains (Gereffi et al., 2005; Humphrey and Schmitz, 2001). In comparison to traditional commodities chains, the high value chains are considered to
be more efficient with increased backward and forward linkages. As efficiency of a supply chain depends upon the extent to which both the backward as well as forward linkages are integrated along with the functions and stakeholders (Narula and Nainwal, 2010; Lambert and Cooper, 1998).

However, India is in the midst of these changes which can be understand in terms of the industrial structure which are typically dimensioned in terms of market size (Minot and Roy, 2007) (Figure 1.4b). Still, the high value supply chains such as vegetables are highly unorganized and inefficient spreaded across the distant country locations (see country vegetable map). As highlighted in the map, major eight vegetables producing states contribute to more than 70 percent of total flows of vegetables in the country. The major aggregation of vegetables is done at five metro locations – Mumbai, Delhi, Kolkata and Chennai including Banglore. Whereas eight country locations are major vegetable processing centers (Figure 1.4c).

Figure 1.4b: Current market size of agricultural sub-sectors in India (year 2011)

Source: Multiple sources

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3Backward and forward linkages are descriptive measures of the economic interdependence of industries in terms of magnitude transactions. A sector’s linkage through its direct and indirect purchases is called its backward linkage. As reverse to backward linkage, a sector is forward linked to other sectors through its direct and indirect sales to them (Cai and Leung, 2002).
**Vegetable Map of India:** Eight major producing states contribute to >70% of total vegetable production in India

**Figure 1.4c: Vegetables hub-centers across country supply chain**

- **Production Centers:** West Bengal, Uttar Pradesh, Bihar, Orissa, Gujarat, Karanataka, Andhra Pradesh, Tamil Nadu
- **Aggregation/Transit Centers:** Kolkota, Delhi, Bangalore, Chennai, Mumbai
- **Processing Centers:** Kolkota, Noida, Hazipur, Gurgaon, Moga, Udham Singh Nagar, Chennai, Khurda
- **Consumption Centers:** 600 small cities, 100 major cities, and towns in the country
As recognized by the relevant literatures, the high value vegetable supply chains are the most complex, least developed, and involves numerous stakeholders at various stages: farmers, village/ market commission agents, wholesaler/sub-wholesalers, food manufacturers, vendors, retailers, and multiple intermediaries who add cost but no/little value to the product (Figure 1.4d). The infrastructure connecting these stakeholders is very weak leading to huge wastage along the chain. The storage and the distribution networks are at worst, so whenever there is even a small supply shock or a small demand shock prices are going haywire. Further, marketing of vegetables are challenging because of the perishability, seasonality and bulkiness and consumption habits of the Indian Consumers. In addition to this, poor equity in supply chain and conventional small scale unorganized retailers, make state of the art supply chain challenging in the present scenario.

Figure 1.4d: Vegetable supply chain in India (covers all possible stakeholders)

As a result, more than 50 percent of produce losses and wastage in the supply chain operations (FAO, 2011). Also, despite accounting for 15 per cent of world’s vegetable production, India has a relatively low, less than 2 percent of the total vegetables produced in the country are commercially processed and exported (Ernst and Young, 2009). The sub-optimal performance of vegetables’ supply chain is largely due to inefficiency caused by high potential risks across the supply chain. The upward
vegetable supply chain is the most risky in a number of ways, including the quantity and quality of production and the costs and, in some cases quality and availability, of essential inputs, such as seed, fertilizers, irrigation water (Rao, 2008; Barnett and Mahul, 2007; Turvey, 2001; Goodhue and Simon). Post-production crops are greatly suffers from poor logistics & transportation, poor handling, lack of processing techniques, lack of quality control practices, and storage (Basavaraja et al., 2007; Rajagopal, 2002). Vegetable marketing introduces additional sources of risk, including price risk, policy risk, and “placement risk” (defined as the risk of not finding a buyer for all or part of one’s production) (Vaswani, 2011; Shilpi and Umali-Deininger, 2007).

Broadly, the vegetables risks can be classified according to their supply chain phases, which are consists of input, production, post-harvest, and marketing& price (Ali and Kapoor, 2008; Skees et al., 2006; Mirinda and Vedenov, 2001; Boehlje and Eidman, 1994).

Managing vegetables risks are critical to achieve the sustainable agricultural growth, food & nutritional security, and improve rural livelihood situation. Recent approaches and developments have the potential to manage the high potential risks facing the vegetable enterprises and its supply chain. Managing risk across the chain not only helps in cutting costs, but also adds to maintain and improve the quality of vegetables market. Identifying these advancements and their relevance to the current needs of millions of smallholder vegetable farmers and other stakeholders including consumers will strengthen and efficient the country’s vegetable supply chain.

The profound changes in food consumption behaviours and future demand for growing population pose challenges to respond the agriculture with shrinking natural resources and ever increasing agricultural risks. Overall, the agriculture growth performance is non-satisfactory; which may have wider, long-term and serious ramifications that can seriously impact food and nutritional security and undermining the poverty alleviation goals of the country. For agricultural growth to occur at the rate required to meet future quality and quantity demand, there is strong need to understand and respond the emerging risk and challenges of 21st century agriculture.
1.5 Problem Statement – Emerging Risks and Challenges across High Value Agriculture Supply Chain

In the 21st century, Indian agriculture has been experiencing a deceleration and is confronted with new challenges causing agricultural performance to be much below to the actual potential of the country. Figure 1.2b depicts the divergence between the growth trends of the total economy and that of agriculture & allied sectors during a span of about 60 years. Growth in agricultural GDP decelerated from over 3.7 percent per annum during early reform period (1991-92 and 1996-97) to only 2.5 percent during ninth & tenth plan period. Slowdown in agricultural growth can largely be attributed to a variety of risk factors such as declining public investment, degradation of natural resources, failure to carry out essential reforms to conserve water and soil, weak rural infrastructures, markets inefficiencies, adverse impact of trade liberalization, disease outbreaks, limited extension and financial services, unabated and weakened support systems and climate change (Ali and Kapoor, 2008; Cotter et al, 2008; Chong, 2005; Hardaker et al., 2004). Agriculture sector has also been widely neglected for decades by donor to developing countries’ as total overseas development assistances allocated to agriculture dropped from 15% in 1980s to less than 3% in 2007 (World Bank, 2007; Global Donor Platform for Development, 2008).

Figure 1.5: Challenges across agriculture supply chain in India
The agricultural situation in the country has become more volatile, competitive, knowledge-led and market-oriented over the years (Singh and Sharma, 2004). It is evident from the fact that unlike the overall economic growth pattern, agricultural performance in India has been quite volatile (measured in terms of Coefficient of Variation, CV) during 2000-01 to 2010-11 was 1.5 compared to 1.2 during the previous decade (1990s) (estimated from CSO 2012 database for agricultural GDP growth). This is almost five times more than the CV observed in the overall GDP growth of the country indicating that agriculture sector, which is characterised by risk is becoming an ever riskier posing serious challenges for agricultural supply chain and its external environment (Figure 1.5). The major supply chain challenges are at the front of productivity, production, post-harvest and marketing. While external environment challenges arises mainly from Policy, Institutional Environment & Globalization including most serious challenges of climate change and depleting natural resources.

1.5.1 Challenges of Agricultural Policy, Institutional & Globalization

Traditionally, India's agriculture development was based on protected policy environment, which included controls on farm inputs, production, market, pricing, trade, storage, transport, and quantitative restrictions on foreign trade. During 1970s huge public investments were made for creating basic agricultural infrastructure such as irrigation facilities coupled with research and extension to augment food production by increasing cropped area and productivity. These policies were primarily intended to attain long-term food security and stabilize agricultural prices. Notwithstanding, agricultural policy had been dynamic in nature. Institutions were created while others were disbanded depending on the exigencies of the time. However, present agricultural situation in the country is remarkably different from that of few decades ago, but too many of India's agricultural policies are still focused on earlier approach. Agriculture being a state subject for policy initiatives and regulations, there has always been overlap of institutional mechanism across the agricultural systems.

Indian agriculture is facing a policy paradox in the era of globalization with serious challenges of declining productivity, climate change, volatility in prices, shrinking farm size and maintaining global quality & safety standards for agricultural trade (Sinha, 2009). Globalization policies of 1990s and beyond have created many challenges for agriculture sector in the country, which has consequences and impacts in
terms of diversification of domestic production systems, vertical integration of the food supply chain, increase in demand for high value food, declining agri-food export, rising food imports, domestic agriculture exposure to international market, and competitiveness (Pinglai, 2006). Today’s main policy challenges are improving productivity and moving towards high-value agriculture and promote rural non-farm sector by maintaining food security for reducing poverty and hunger.

The environment for Indian agriculture and policy is changing fast. The public investment in agriculture sector declined from 3.4% of agricultural GDP in the early 1980s to 1.9% in 2001-03 (Mani et al., 2011). In terms of composition, the share of public investment in total investment decreased significantly over time from about 50% in the early 1980s to less than 20% in the decade of 2000s (Dev, 2012). In other words, the share of private investment increased from about 50% to 80% during the same period. Likewise, overseas development assistances allocated to agriculture is dropped from 15% in 1980s to less than 3% in 2007 (World Bank, 2007). Regarding procurement policy, the Commission for Agricultural Costs and Prices (CACP), which recommends prices for many important crops in considerations of cost of cultivation, global and domestic prices, demand and supply etc. is helping only few crops and few regions in the country. Also, the current policies support do not appear to be meeting the key policy goals of protecting marginal and small farmers. These declines in public investments and overseas contribution have been matched by poor performance of agriculture and disappearance of agricultural research systems and other supports. Also, agricultural policy also lack in the strong government commitment to implementing basic social protection measures for small farmers and poor consumers. However, to provide new direction to agriculture, the central government launched National Agricultural Policy in 2000 aiming at tapping the vast untapped growth potential of Indian agriculture and attaining the agricultural growth of 4 percent per annum.

Various mission mode programmes such as National Horticulture Mission, Cotton Mission, Oilseeds and Pulses Mission etc were launched by the Government. However, due to lack of proper institutional mechanism, the expected benefits couldn’t be realized. The existing institutional support mechanism for Indian agriculture is also grossly inadequate to meet challenges of 21st century agriculture. The weak institutions

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*It may be noted that 90% of the private investment is made by farmers for on-farm production.*
for managing, coordinating, overseeing, and monitoring seriously hinder the attainment of an evidence-based and inclusive policy process. There is strong need to change and strengthen the entire range of institutional arrangements whether they are concerned with use of natural resources, inputs, marketing and trade or R&D and transfer of technology. Considering the outstanding performance of some non-government organizations (NGOs) and community organizations of farmers, it is imperative to involve them in the new institutional arrangements. There can be better ways of more efficient food management practices in procurement, buffer stock and public distribution system (PDS).

1.5.2 Challenge of Climate Change and Natural Resources

Climate change, resulting mostly from global warming, has been among the major challenges facing agriculture today. Extended drought periods and heavy rainstorms are becoming common features of the weather (Met Office 2005). The agriculture sector in developing countries is the most vulnerable to climate change as compared to developed one, because they have fewer resources to adapt in all sorts: socially, technologically and financially (UNFCCC, 2007). According to FAO (2005) estimates for developing countries, 11 percent of arable land could be affected by climate change, including a reduction of cereal production in about 65 countries, about 16 percent of agricultural GDP. This has raised fears that the world, particularly developing countries, may not be able to grow enough food to ensure that future population are adequately fed (Harris and Kennedy, 1999).

In India, while there is considerable uncertainty as to how climate change will affect specific regions in the country, the general consensus at present is that temperatures will rise through most of this century and many parts will experience a reduction in average annual rainfall, while some regions may face drought. Some simulation studies on the impact of climate change on major foodgrains like rice and wheat yields indicate that a 2°C rise in mean temperature may reduce the potential grain yields of both the crops by about 15-17% in north India (Kaur and Hundal, 2007; Aggarwal and Sinha, 1993). Another study by Geethalakshmi and Dheebakaran (2008) shows that temperature and precipitation changes may reduce the rice yields (during the kharif season) by 10-15 percent by 2020 in the state of Tamil Nadu. By 2050, the
magnitude of yield decline would aggravate further to 30-35% (Kumar and Nath, 2010).

At the country level, a substantial decrease in wheat production is likely to occur if the existing pattern of climate change continues. After incorporating the climate change effect, the wheat output is projected to barely reach 75 million tonnes in 2020 (as against projection of nearly 100 million tonnes without considering climate change impact). Beyond 2020, wheat yield have been projected on the basis of input growth are unlikely to materialize and the production would come down sharply (Figure 1.5.2). The adverse effect of climate change on short duration crops and perishable items such as fruit, vegetables and spices, due to high environmental susceptibility of these crops, have also been reported (Sivakumar and Stefanski, 2008). Similarly, due to high sensitivity of livestock and marine production to climate change, the livestock productivity is also expected to decline, which may have adverse consequences to nutritional security (Sirohi and Michaelowa, 2007).

Figure 1.5.2: Possible impact of climate change on wheat production in India

![Graph showing possible impact of climate change on wheat production in India.](source: NATCOM, 2004(adopted from Dasgupta and Sirohi, 2010)

Apart from the climate change, the degradation of natural resources particularly soil erosion & loss of soil structure, reduction in soil organic matter, falling ground water tables, drying rivers or floods, and pollution are alarming about the decline in future food supply. Also, per capita land availability in India has declined from 0.89 hectare in 1951 to 0.3 hectare in 2001 while during the same period; per capita availability of agriculture land has declined from 0.48 hectare to 0.14 hectare (Ministry
of Environment & Forest, GoI\textsuperscript{9}). The declining availability of per capita land resources is further exacerbated by degradation and desertification of land. Thus, the likely impact of climate change and diminishing natural resources on food production and productivity in India can constrain attainment of future food security from the domestic production.

1.5.3 Production and Productivity Challenges

Agricultural production in the country has moved through various stages during last 60 years and now showing stagnation in the recent years. Due to this stagnation in agricultural growth, the time has come to develop innovative technologies related to seed, fertilisers, irrigation system and good agricultural practices, for promoting important crops which are more productive, profitable, cost-effective, sustainable, and resilient. One of the main problems of Indian agriculture is its low productivity as compared to global averages (Figure 1.5.3a). Indian agricultural yields are among the lowest in the world, although there has been marked improvement in per hectare yield since 1950-51. The world average yield for cereals is 152 percent higher than Indian yield. Similarly the world average yield for vegetables is 146 percent higher than Indian yield for the same.

Figure 1.5.3a: Yield of cereals & vegetables – A comparison

![Figure 1.5.3a: Yield of cereals & vegetables – A comparison](image)

Source: FAOSTAT

\textsuperscript{9}http://www.envfor.nic.in/divisions/ic/wssd/doc1/chap6/da_page_6_1.htm
The main cause of this low per hectare yield is low fertility of soil and less care to replenish it through balanced use of artificial fertilizers. Soil erosion is not only a major cause for decreasing soil fertility but also the loss of valuable cropped land. Table 1.5.3a presents the soil fertility maps of India which is based on systematic survey and analysis of more than 2.5 lakh soil samples conducted by the All India Coordinated Research Project (AICRP), indicating deficiency levels in the soil. It clearly shows that about 63 percent of soils are low, 26 percent of soils are medium and only 11 percent of soils are high in available nitrogen. Similarly, about 42 percent, 38 percent and 20 percent soils are low, medium and high, respectively, in the availability of phosphorus. About 50 percent soils are high in potassium, 37 percent medium and only 13 percent low in potassium. The deficiency level of Zn was to the extent of 49%, 33% of B, 13, 7 & 4% of sample rating low in Fe, Mo and Mn.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Extent of deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>L: 63%; M: 26%; H: 11%</td>
</tr>
<tr>
<td>P</td>
<td>L: 42%; M: 38%; H: 20%</td>
</tr>
<tr>
<td>K</td>
<td>L: 13%; M: 37%; H: 50%</td>
</tr>
<tr>
<td>S</td>
<td>L: 40%; M: 35%; H: 25%</td>
</tr>
<tr>
<td>Zn</td>
<td>49%</td>
</tr>
<tr>
<td>Fe</td>
<td>13%</td>
</tr>
<tr>
<td>B</td>
<td>33%</td>
</tr>
<tr>
<td>Mo</td>
<td>7%</td>
</tr>
<tr>
<td>Mn</td>
<td>4%</td>
</tr>
</tbody>
</table>

Source: ICAR

With intensive cropping system using only NPK fertilisers and with limited use of organic manures, soils became deficient in a large number of elements (Figure 1.5.3b). In India, about 80 million hectares of cropped area is facing the problem of soil erosion. Planning Commission (Govt of India) recognized the specific regional constraints attributed to low productivity in the concerned states (Table 1.5.3b).
Figure 1.5.3b: Emerging deficiencies of plant nutrients vis-a-vis increased foodgrains production

Table 1.5.3b: Region specific factors that can be attributed to low productivity

<table>
<thead>
<tr>
<th>Agro-climatic region</th>
<th>States/Parts of states</th>
<th>Region-specific constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Himalaya Region</td>
<td>J&amp;K, HP, Uttarakhand</td>
<td>Severe soil erosion, degradation due to heavy rainfall/floods and deforestation, poor road, poor input delivery, inadequate communication infrastructure and marketing.</td>
</tr>
<tr>
<td>Eastern Himalayan Region</td>
<td>Assam, NE States, Sikkim</td>
<td>Aluminium toxicity and soil acidity, soil erosion and floods, shifting cultivation, non-availability of electricity, poor road, poor input delivery system and communication infrastructure.</td>
</tr>
<tr>
<td>Lower and Middle Gangetic Plains Region</td>
<td>West Bengal, Bihar, Eastern UP</td>
<td>Flood/water logging, improper drainage, salinity/alkalinity, arsenic contamination, Non-availability of electricity, high population growth, poor road and communication infrastructures.</td>
</tr>
<tr>
<td>Upper and Trans-Gangetic Plains Region</td>
<td>Western UP, Punjab, Haryana</td>
<td>Groundwater depletion, decreasing total factor productivity, micronutrient deficiencies, inadequate-availability of electricity, and high population density</td>
</tr>
<tr>
<td>Eastern Plateau and Hills Region</td>
<td>Orissa, Jharkhand, Chhattisgarh</td>
<td>Moisture stress, drought, soil acidity, iron toxicity, non-availability of electricity, high population growth, poor road, poor input delivery and communication infrastructure.</td>
</tr>
</tbody>
</table>

Source: Planning Commission

1.5.4 Post-harvest and Marketing Challenges

While increasing productivity and production are essential components of a vibrant agricultural sector, improved post-harvest\(^\text{10}\) practices and marketing are also essential to

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\(^{10}\) A post-harvest system is concerned with the post agricultural agro-industries sphere and includes technologies of storage, transportation, and processing of agricultural raw materials into food products (Meliczek, 1985)
ensure high-quality products reach the markets and farmers' income gain. The existing post-harvest practices in the country are one of the major concerns, causing huge post-harvest losses particularly of perishable items such as fruits and vegetables. It has caused losses in production, inputs and valuable nutrient quality. The sub-optimal growth of food processing and inefficiencies in marketing including and poor institutions in India is another constraint contributing to high losses and wastage of the farm produce, which translate into less income for farmers and the higher prices for the consumers.

Agricultural marketing in India is highly unorganized and inefficient. Marketing in agricultural commodities is assuming increasing importance in the wake of ushering in second green revolution, improving the living standards of farm families, making India hunger free and turning poverty into history in the shortest possible time. The challenges facing the marketing system are quite different than what these used to be about two decades before (Planning Commission, 2007). An efficient and organized marketing system is required to enable agricultural producers to build a platform where they can better market their produce. Such agricultural marketing system not only enables farmers to market their produce at local level but also explores avenues for the expansion of the market globally. However, there is need for intervention from various government and non-government agencies to act as catalyst in assisting farmers in marketing their produces both at local and global platform. Poor front end infrastructure such as storage facilities and improper warehousing facilities results in as high as 40-50% post harvest losses (however it varies from produce to produce) and wastage, which occurs across the entire food supply-chain from farm gate to consumer end. Imperfect market conditions and restrictions on the movement of agricultural commodities are not letting the farmers to realize the true value of their produce, whereas it is causing the consumer to pay a much higher price than warranted. There is limited access to the market information (generally blocked by intermediaries), and multiple channels of distribution that eats away the pockets of both farmers and consumers.

The 4Ps - price, product, place and promotion is the core principle of marketing but in the case of agricultural marketing in India it is not exactly the marketing in the literal sense and we can call it as 'distributive handling' of agricultural produce as there
are number of intermediaries involved who adds cost but no value to the product. The escalation in the cost of the produce is to an extent of 250 percent of the cost of production at the farm level and same is set out in the figure below (in case of vegetables) (Figure 1.5.4). However with the liberalization, privatization and globalization, the economic scenario in India has drastically and tremendously changed over the years. As a result, changes in the ‘distributive handling’ is being reinvented with the rise of retail giants who are the major buyers in bulk quantity and who constantly look for differentiated, graded, standardized, processed and packaged products rather than undifferentiated ones. The country need to develop an integrated mechanism linking the post-harvest and marketing activities that ensures the fast reach of perishable produce to market at the right time with right quality and quantity at right remuneration to the farmers.

Figure 1.5.4: Cost build-up for one kilogram of average basket of vegetables

![Cost Build-up Diagram]

Source: Agricultural Marketing Division for State Agriculture /Agriculture Marketing Ministers Conference (23.04.2008) by UKS Chauhan

History has shown that Indian agriculture can meet big challenges. There is sufficient evidence in the country itself that has shown that India come out from the high level of poverty and food-deficit nation to now food secure nation with surplus supply of food to the world. Between 1951 and 2011, the India’s population increased by 335% (36.1 to 121 crores) and foodgrains production rose by more than 500% (from 50.83 to 254.4 million tonne), is a sufficient evidence of country’s agricultural production capacity (Census, 2011).

The recent challenges for Indian agriculture in 21st century is to increase the productivity and production and remove the inefficiencies involved in post-harvest and marketing operations, in order to meet out the challenges posed by agricultural risks.
Risk affects both individual producers and the overall performance of the agricultural sector. At the productivity and production front, there is the wide gap between what the technologist gets in the experimental farm and what a farmer gets on his farm and also a wide gap between the "best-practice" farmer and the common run of farmers. At the post harvest and marketing end, significant losses and wastage of produce leads to quality and quantity losses in the food value chain. Minimising food losses and waste along the supply chains can make a big difference in improving the future food supply situation.

Small-scale farmers', who are the primary stakeholders in agricultural supply chain, constitute more than 70 percent of rural households (World Bank, 2007). Importantly, their importance can also be understood from that fact that they continue to contribute significantly to the agricultural production, food security, and rural poverty reduction in the country. However, they confront with new challenges in accessing the productive resources, integration into high value chains, adaptation to climate change, and market volatility and other risks and vulnerability. Also, they face multiple sources of risk arising due to the vagaries of weather, increasing cost of inputs, limited access to credit & crop insurance, lack of infrastructure & storage facilities, low economies of scale, lack of bargaining power, poor market linkages, lack of market information, market price fluctuations of produce, globalization of chains, and the unique political economy of food in domestic and international settings (Cottern et al, 2008; Tang, 2006; Chong, 2005; Hardaker et al., 2004). Further, emerging demand for high-value food commodities raised question whether the smallholders would be able to participate in such a fast changing commercial agriculture (Joshi et al. 2004; Kumar et al., 2003).

High-value agricultural commodities often characterized by perishable in nature, irregular supply of products due to seasonability of production, high income elasticity (hence growing demand), price sensitivity to quality & safety, and also market prices are highly volatile; the small-scale producers generally feed the local markets that are usually thin and fragmented. Marketable surplus of an individual small-scale producer is too small to be bargained and traded remuneratively in distant markets due to high marketing and transaction costs (Escobal et al. 2000). All these factors escalate the transaction costs and increase risks in production and marketing considerably that may again discourage the smallholders. Some generic constraints also
includes weak and/or non-existent farmer organizations, low levels of agricultural education and social capital, lack of vertical co-ordination, limited technical and marketing expertise & knowledge. Such constraints have resulted in a concentration in the supply base with large farmers, and enterprises, and a resultant decrease in small-scale farmers' involvement. Managing risks is critical for agricultural growth and development. Managing risk, typically, involves the use of a range of practices, techniques and tools in order to counter the risk across the agricultural chain (Ali and Kapoor, 2008; Miller et al, 2004; Clark, and Brinkley, 2001).

India's agricultural supply chain is still predominantly unorganized; there are several inefficiencies due to potential risks involved at its various functions. There have been several attempts to manage this – from government, NGOs, Community Organizations, private agencies, and research institutions. Though, there has been some success in these attempts, these have not scaled up fast enough to manage the chain across different commodities efficiently and effectively. Given the complexity of agricultural production and post-harvest operations & marketing activities; coupled with the problems of poor agricultural practices and lack of infrastructure and deprived support mechanism, there is an urgent need to innovate and adopt quick & practical solutions. Organizing resource poor farmers and linking them into an integrated and effective supply chain framework/system, which comprise of efficient market and institutional support system may help to find out the solutions for effective agricultural risk management and to respond the 21st century challenges for efficiency gain in agricultural supply chain.

1.6 Objectives of the Study and Research Questions

This study aims at providing a generic and integrated framework for the systematic management of potential/ critical risks in the supply chain with special reference to upstream vegetable supply chain. The overarching objective of this study is to investigate the clustering approach of managing risks in upstream vegetable supply chain in India. Additionally, this study examines factors that affect the identification and treatment of potential/critical supply chain risks.

This study has been conducted with the following specific objectives and is expected to address the specified questions mentioned against each objective:
1. To review the literature on risk and risk management in agriculture; and develop an integrated framework of supply chain risk management.

The research questions expected to be answered: 1) what are the existing approaches to classify agricultural risk? 2) what are the sources of agricultural supply chain risks? 3) what are various agricultural risk management approaches and mechanisms? 4) What is the research gap on existing literature on risk management?

2. To analyze the transition and structural shift in Indian Agriculture and discuss the emerging trends towards the high value agriculture and mapping the vegetable value chain;

The research questions expected to be answered: 1) what are the trends in high-value agriculture in terms of area, production, productivity and value of output? 2) Examining India and Uttar Pradesh as the vegetable basket of world and India respectively. 3) what is the emerging structure of high value supply chain specially for vegetables?

3. To identify, assess/evaluate and prioritize the various sources of risk in upstream vegetable supply chain; examine the disruptive ranges of critical risks across the chain.

The research questions expected to be answered: 1) what are the potential sources of risk in the vegetable supply chain comprised of input, production, post-harvest harvest, and marketing & price? 2) what is the difference in the realization of risk to cluster and non-cluster producers? 3) what are the critical sources of supply chain risks and measure their disruptive ranges?

4. To discuss the clustering approach to manage potential/critical risks across upstream vegetable supply chain, and compare the risk control strategies of cluster and non-cluster farmers;

The research questions expected to be answered: 1) why clustering is an effective approach of risk management? 2) what are the major steps and activities/task of the clustering approach? 3) what are the differences in critical risk management strategies of cluster and non-cluster producers?
To review of risk management (minimization/reduction) within and between cluster & non-cluster across the vegetable supply chain as a result of risk control actions.

The research questions expected to be answered: 1) what is the importance of risk review? 2) what are the results of adoption of risk control measures? 3) compare the risk minimization/reduction between of cluster and non-cluster producers.

6. To investigate the factors affecting identification of critical risks and its management.

The research questions expected to be answered: 1) what are the socio-demographic factors that affect the identification of critical risks across supply chain? 2) what are the socio-demographic factors that affect the management of critical risks across the supply chain?

The underlying premise of the study is that agricultural growth in India can be achieved by managing potential risks of high value agriculture across the supply chain through an integrated approach of risk management which integrate farmers' (particularly small-scale producers) in the supply chain and also promotes adoption of effective risk control measures.

1.7 Thesis Outline

This thesis is structured into eight chapters as per given descriptions below:

Chapter 1 Introduction

This chapter presents the background and interest of this research. It critically reviews the growth performance of Indian agriculture since independence and briefly discusses the twists and turns during the plan periods. It also analyses the transition and structural shift in Indian Agriculture. Further, it critically examines India and Uttar Pradesh as the vegetable basket of world and India respectively. The chapter also maps the emerging high value supply chain structure in the country with special reference to vegetables. Then, it describes the statement of problem in terms of risk and challenges facing Indian agriculture in its transition to sustainability phases in the twenty-first century. In addition, this chapter
describes the detailed objectives, research question, and the structure of this dissertation.

Chapter : 2 Review of Literature and Theoretical Foundation
This chapter provides review literatures relevant to the research objectives. It builds a theoretical foundation upon which the research progresses. Commencing with the description of the concept of risk and risk management, it discusses the relevant literature on risks and uncertainty in agriculture in order to develop a better understanding of the issue. Further, it critically provides literature on sources of risks and risk management approaches & strategies. The review provides the theoretical foundation to this research.

Chapter : 3 Conceptual Framework and Research Hypotheses
This chapter introduces the conceptual framework of integrated supply chain risk management in agriculture and discusses hypotheses predicting the relationship and effect of clustering approach and socio-economic factors on managing potential risks.

Chapter : 4 Data and Methodology
This chapter provides a description of the data and methodology used in this study. Briefly, it discusses about the sampling procedure for data collection, survey instrument, and data analysis procedures and techniques employed in the study. The socio-demographics and farm characteristics of the sample are also summarized.

Chapter : 5 Results and Discussion
This chapter is divided into two major sections A & B.

The section - A presents a systematic approach of managing risk across vegetable supply chain based on primary data collected from the field survey. It starts with the analysis for the identification and assessment of various sources of risk across the vegetable supply chain. Then, it prioritizes the risks using Pareto Analysis and identifies the critical risks in the supply chain. In addition, it investigates various factors that affect the identification of critical risks.

The section - B analyses the clustering as an integrated approach for managing potential/critical risks across the vegetable supply chain, and
also compares the risk control strategies of cluster and non-cluster farmers. Moreover, it investigates the factors affecting management of the critical risks in supply chain. Lastly, it evaluates the impact of clustering on risk minimization/reduction and puts observations on the same.

Chapter: 6 Conclusion, Implications and Recommendations
This last chapter ends this thesis with the conclusions drawn as well as their implications. It also provides practical recommendations for actions arise from the findings and observations of this research study. Also, it hints opportunities for further research.