CHAPTER II

REVIEW OF LITERATURE

In this chapter, attempts have been made to review some important researches conducted in India and abroad having relevance with the present study. The literatures have been reviewed in terms of the following subheads.

2.1 Factors influencing risks associated with crop production,

2.2 Risk management strategies,

2.3 Risk assessment and optimization of resource use.

2.1 Factors influencing risks associated with crop production

The literature on technology adoption at the farm level outlined many factors viz., physical, economical, technological, climatic etc. influence farmers’ choices about what crops to grow, whether to use a new technology, and how to manage their land. Just as individual consumers have different preferences about products they consume, farmer’s characteristics, asset endowments, risk preferences, and intertemporal considerations affect their choices. Input market conditions can shape farmer’s production decisions in a number of ways; dynamics of local and seasonal labour availability may mean that it is not profitable to grow a crop with a very narrow harvesting window in a month where the overall demand for agricultural labour is high in the region (Binswanger and Rosenzweig, 1986).

Weather plays a major role in the outbreak of diseases and growth of crop pests. Usually, the pest and disease organisms are always present at a low level of intensity and can multiply rapidly when the weather conditions are favourable and the plants become susceptible to attack (Gadgil, Rao, Joshi and Sridhar, 1996). In particular, disease epidemics are always due to favourable weather conditions (Mayee, 1996). The causative relationship between weather parameters (such as rainfall, temperature, humidity) and pest build up is however very complex and is specific to the pest, crop, soil and management practices (Rao and Rao, 1996).

A risk-averse farmer or one who is credit or income-constrained may be less likely to adopt new technologies, even if they are likely to reduce susceptibility to risk.
or increase productivity or income over the long-run (Nerlove et al., 1996, Hanson et al. 2004). Farmer’s attitudes, resource availability, education and knowledge are especially important in such case. Farmers may be risk averse towards making changes in cropping decisions or adopting new agricultural practices or might have very conservative attitudes toward technology or lower or higher levels of concern for the natural environment (McCann 1997, Hanson et al., 2004, Musshoff and Hirschauer 2008, Serra et al., 2008). McCann (1997), Knowler and Bradshaw (2007) also observed that a farmer’s income or resource base and ability to obtain credit will also influence his/her choice of crops, farming systems, and willingness to invest in new crops, systems, or technologies.

According to Patrick (1998), some of the risk and uncertainty components are lack of rainfall, price changes, lack of labour for required time, machinery breakdowns in unexpected situations and changes in government policy and other similar factors. These factors are the main causes of income fluctuations in agriculture. Because of risk and uncertainty components, big fluctuations in yields and prices occur and this situation leads to important income differences from one year to another. The risk and uncertainty conditions are reflected in terms of prices of goods purchased by farmers and amounts of production. These are therefore of crucial importance for a farmer’s income. Risk management strategies are developed to provide some protection in situations in which the consequences of a decision are not known when the decision is made. The various risk management strategies have different effects on the farm business, but none of the responses can provide protection from all types of risk.

Some risks have to be more explicitly taken into account than others. If potential losses are big, more attention has to be paid to the choice among the available alternatives, as the differences between the various outcomes may be significant. Some risks farmers have in common with other businesses, others are unique to farming). The various risks are often interrelated. For example, the institutional risk of a change in price support has an influence on price risk. Likewise, imposing environmental restrictions has an impact on yield risk. Risks of all categories have an effect on the income situation of a farm household. The most important risks can be classified as follows (Anonymous, 2001).
**Production risk:** It comes from the unpredictable nature of the weather and uncertainty about the performance of crops or livestock, such as through the incidence of pests and diseases, or from many other unpredictable factors (Hardaker et al., 2004). Early frosts and droughts are hazards that farmers know only too well. Weather risk, despite more than 100 years of trying to overcome it with technology, can hurt producers’ incomes. By the same token, weather can provide agricultural producers with a bounty. Rain at the right time is a blessing, but during harvests a curse. (Catlett and Libbin, 2007).

**Price or market risk:** Prices of farm inputs and outputs are seldom known for certain at the time that a farmer must make decisions about how much of which inputs to use or what and how much of various products to produce. Farmers almost the world over are being exposed to unpredictable competitive markets for inputs and outputs, so that price or market risk is often significant and may increase over time. This risk includes risks stemming from unpredictable currency exchange rates (Hardaker et al., 2004).

**Political risk:** Governments are another source of risk for farmers. Changes in the rules that affect farm production can have far-reaching implications for profitability. For example, a change in the laws governing the disposal of animal manure may have significant impacts; so too many changes in income-tax provisions or in the availability of various incentive payments. Horticultural producers may be badly affected by new restrictions on the use of pesticides. Risks of these kinds may be called institutional risk. Institutional risk embodies political risk, meaning the risk of unfavourable policy changes, and sovereign risk, meaning the risk that foreign governments will fail to honour commitments such as trade agreements. Also under this heading we might include relationship risk, meaning the risks inherent in the dealings between business partners and other trading organizations (Hardaker et al., 2004).

**Human or personal risk:** The people who operate the farm may themselves be a source of risk for the profitability of the farm business. Major life crises, such as the death of the owner or the divorce of a husband and wife owning a farm in partnership, may threaten the existence of the business. Prolonged illness of one of the principals may cause serious losses to production, or substantially increased costs. And carelessness by the farmer or farm workers, in handling livestock or using machinery
for example, may similarly lead to significant losses such risks may be called human or personal risk (Hardaker et al., 2004).

The types of risk and constraints the farmer faces are not just macroeconomic; they often take the form of limited availability of respond inputs, such as fertilizer, water, labour, or capital. Using diversification, farmers can to input-related risks by choosing to form a combination of crops with different characteristics (i.e., crops that are more or less drought resistant, or crops that are harvested in different seasons to mitigate labour risks). One of the most important types of input constraints and risks the farmer may face is labour or capital constraints and risks associated with harvesting. The labour and capital requirements for many agricultural crops vary seasonally and are often far higher at the time of harvest than at any other point in time during production. In the case where farmers are labour constrained and rely mainly on family labour, or require timely availability of costly, hired labour, farmers may diversify and grow several different crops for which the labour requirements are peak at different points throughout the year so as to avoid fruit rotting on the tree or vegetables withering on the stalk (Musser and Patrick, 2002).

Many policies that do not specifically target agriculture, such as labour and immigration or water policies have a significant effect on the costs of agricultural production. For example, laws such as those that regulate pesticide usage and application or limit water use can make it more costly to produce using synthetic pesticides or inefficient irrigation systems. While in the short-run such regulations may have a negative impact on farmer’s welfare, they also serve to stimulate innovation and adoption of new technologies in order to comply with regulations and reduce the costs of production (Lichtenberg, 2002).

Rogers (2003) noted that communities closer to urban centres are likely to adopt new technologies more quickly. Consumer attitudes and willingness to pay (i.e., the maximum amount a consumer would be willing to pay for a good or attribute) for differentiated crops or particular attributes, such as organic or local production or pesticide-free varieties, also affect the agricultural systems that emerge in response to the demands of a changing market.

Policies and regulations can impact the profitability and evolution of different agricultural systems by facilitating or hindering trade in particular types of agricultural
products, by influencing farmer decisions about what crops to grow or how much land to devote to farm use etc. Policies such as price supports or set-aside programs, or by making different types of production or land-use relatively more or less “expensive” via regulations, taxes and subsidies, or standards influence farmer’s decisions (Hardie et al., 2004).

Agricultural households in developing countries are characterized by high poverty levels, large proportion of their production is kept for subsistence needs and selling surplus to the market to meet households’ basic needs. Production, consumption and reproduction decisions are integrated. Not all products and factors of production are tradable because of high transaction costs, shallow markets, and risks and uncertainty of weather conditions which drive purchase prices up and selling prices low. Limited access to credit is a frequent cause of market failure, as the household cannot satisfy an annual cash income constraint, with expenditure higher than revenue at certain periods of the year. The household faces a price band, where the purchase price is higher than the selling price (Bagamba et al., 2004).

Farmers are typically risk-averse (where risk implies, for example, that the farmer knows that the price of their outputs will vary with some known probability). They face many different types of risk including price risk (e.g., the risk that the price that they receive for their output will be higher or lower than average in a given year), yield risk (e.g., the risk that a pest infestation or drought will cause yields to be lower than average), input supply risk (e.g., the risk of a water shortage or a labor shortage at a critical point in the production process) and other types of risks (e.g., the risk of a family member getting sick or a tractor breaking down). Many of these types of risk (e.g., price risk, yield risk) contribute directly to profit risk, which is ultimately most important to the producer. Farmers and their families can respond to risks in many ways, and can respond ex-ante (before the event) in precautionary ways, or ex post (after the event) to try and minimize their losses. (Mcnamara and Weiss, 2005).

The Kenyan agricultural sector is predominantly small-scale based and is characterized by poor farmers who seem to be caught in the vicious cycle of low investment, low productivity and low incomes. The farmers also face various exogenous risks emanating from the biophysical and socio-economic environment in which they operate. These risks, coupled with farm specific resource endowments and constraints
affect the level and variability of farm revenues (Kuyiah et al., 2006).

Lack of knowledge and information about the costs and benefits of adopting new technologies or conservation practices or lack of knowledge about how to implement such technologies or practices will also affect a farmer’s propensity to adopt them (Chavas et al., 2010, Chavas and Kim, 2010).

According to Zilberman et al., (2012), input price volatility and economies of scale with respect to inputs or technologies can also contribute to farmers planting different mixes of crops, or planting more land in one crop than another. Similarly, output market conditions including prices, price variability, transportation costs, and supply chain transactions costs are important determinants of how profitable it is for farmers to grow a crop. Many of these variables are influenced by location.

2.2 Risk Management strategies in Agriculture

Risk strategies are defined as the methods applied to remove or reduce partly the effects of factors creating risk in agriculture. To reduce effects of risk or survive in the poor conditions for farm activities, it is necessary to use risk strategies. The selection of good risk strategies depends on the farm operator, the financial situation, and risk attitudes of the farmer. The risk strategies are classified in several ways in the literature (Kay and Edwards, 1994; Hardaker et al., 1997; Musser, 1998).

According to Key and Runsten (1999), functioning of the insurance market is an important rationale for contract farming especially for farmers producing non-traditional crops. This is because the production of high valued crops is more uncertain compared to traditional crops due to its susceptibility to natural hazards such as diseases and climate change. The non-traditional crops require very high investment and at the same time price of the final produce is highly variable, imposing a huge income risk on the farmers. In the absence of a well functioning credit market, a contract offering a fixed price can serve as risk insurance for the producer. The firm profits by earning a risk premium that the risk-averse farmer is willing to pay for the certainty of a guaranteed market outlet

Risk strategies dealing with variability are commonly grouped into production, marketing, and financial responses. As the names imply, production and marketing responses deal directly with production and market types of risk. Production
responses generally act to reduce risk by reducing the variability in production. Marketing responses may also reduce risk by narrowing the range of possible outcomes or may involve transferring price risks to other individuals or institutions. In contrast, financial responses generally emphasize the firm’s capacity to bear risk and do not reduce the probability of an unfavourable event. Financial responses, such as insurance, may also transfer risks to others and provide the means with which the firm can withstand adverse consequences should they occur (Patrick, 1998). Someresearch works have been conducted on the risk exposure and risk coping strategies of farmers (Nelson, 1997; Martin and McLeay, 1998; Musser, 1998; Coble et al., 1999; Harwood et al., 1999; Keith, 1999; Babcock et al., 2000; Akcaoz, 2001).

Ortmann et al., (1995) conducted a study among 199 commercial farmers in the province of Kwazulu-Natal, South Africa and they determined risk sources and strategies. Factor analysis suggested that crop gross income, government policy, livestock gross income, credit access, government regulation and cost were (described as) risk sources. Risk strategies were described as marketing, insurance, production, financial, cost reduction and assurance.

As risk is an inescapable fact of life, in particular in agriculture, farmers must try to manage risk effectively. Risk management is an integral part of good management of a farm, being a way to avoid losses and exploit opportunities. Results of a field survey with 731 Dutch livestock farmers were indicate that contagious animal diseases and the death of the farm operator are the major sources of risk for livestock farmers. Furthermore, producing at the lowest costs and buying insurance are the most important risk management strategies (Huirne et al., 2000).

Agro-forestry can also be used as a complementary or alternative agricultural practice especially where others are limited by climatic conditions. Currently, land degradation, soil erosion and declining soil fertility has constrained sustainable use of existing agricultural land thus leading to the increased need to practice agro-forestry (Franzelet et al., 2001).

Meuwissen et al., (2001) studied farmers’ perceptions of risk and risk management, by using factor and regression analyses, amongst Dutch livestock farmers. Results showed that price and production factors were perceived as important sources of risk. Insurance schemes were perceived as relevant strategies to manage risks.
Risk management is a complex process which includes several steps (Hardaker et al., 2004). The first step is to identify the risk and its nature. The second is to analyse the risk, such as to consider the possibility of occurrence and to assess the consequences of particular interest are the frequency and distribution of occurrence, the magnitude of potential loses, and their randomness and correlation with one another. Risk assessment consists in deciding if action is needed. The following section will present various risk management strategies used by farm households. The final stage of the risk management process is to monitor and review the strategy applied in order to evaluate the balance between costs and benefits both in the presence and in the absence of this strategy (Moredu, 2000).

Risk management involves the selection of methods for with all types of risks in order to meet the decision maker’s goal while also taking their risk attitude into account. This means calculating the risk return trade-off in designing risk management strategies is an important target in agricultural business (Kobzar, 2006).

A study on farmers’ perception on risks in fruits and vegetables production revealed that in general, the price and production risks have been perceived as the most important sources of risk in production of fruits and vegetables in the area. The study has argued that public intervention can facilitate better risk management through improved information system, development of financial markets and promotion of market-based price and yield insurance schemes, thus ensuring that the marginal farmers are able to benefit from these interventions as well as participate in the emerging systems (Ali and Kapoor, 2008).

Barman and Das (2010) in their study on socio-economic factors influencing adoption of farm level soil and water conservation practices in the riverine areas of North Bank Plain Zone of Assam applied a Tobit model and observed, the family size, profitability of conservation methods, affect of soil erosion and water depletion on crop yield, off farm employment and the land tenure system as the important and significant variables influencing adoption of soil and water conservation practices. Availability of farm labour has significantly influenced the adoption of conservation practices. This finding is further evinced by the negative relationship between conservation effort and off farm employment. The institutional variable of land tenure has also significantly influenced the adoption of conservation practices. Farmers with permanent ‘land patta’
demonstrated more inclination towards adoption of conservation measures as compared to ‘periodic patta’.

When looking at previous studies examining adoption of risk management tools, we found a large number of studies evaluating adoption of tools associated with the management of price and yield risk as well as the factors influencing adoption of these tools (e.g., crop insurance, forward contracting, future and option markets) (Shapiro and Brorsen, 1988; Knight et al., 1989; Makuset al., 1990; Goodwin and Schroeder, 1994; Harwood et al., 1999; Mishra and El- Osta, 2002; Sherrick et al., 2004; Davis et al., 2005; Pennings et al., 2008; Velandia et al., 2009).

However, there are only few studies (Sriboonchitta et al., 2008; Asfaw, Mithofer, and Waibel 2010; Kersting and Wollni, 2011; Boys, 2013) that have looked at the adoption of tools or strategies to reduce product liability risk such as Product Liability Insurance and Good Agricultural Practices (GAP), among fruit and vegetable producers.

2.3 Risk assessment and optimization of resource use

2.3.1 Risk assessment

A number of studies have tried to deal with the component of risk in farming, including the major causes of risk such as plant and animal diseases, variation in the weather and other environmental changes, price fluctuations, variation in human ability and judgment, etc.

Hazell (1971) proposed the use of MOTAD (Minimization of Total Absolute Deviation from Mean) as an alternative to the mean variance criteria for planning under risk. It attracted the attention of researchers in India and abroad as it can be solved on conventional linear programming code and also enables better post optimal analysis. Mruthunjaya et al., (1979), Singh et al., (1983), Randhiret al., (1993), Jha (1996) also applied MOTAD to formulate risk efficient farm plans. Belete (1993) explored the possibilities of improving production and income on small farms through better allocation of resources. It pertained to the area that represented the low potential cereal crops zone of Ethiopian high land in the Shoa region. The basic primary data were drawn from 50 randomly selected farms in the area and secondary data were obtained from ILCA. Linear programming and MOTAD were used as analytical tools. The results of the study indicated a substantial potential for increasing net farm cash
incomes by efficient allocation of available resources under current level of technology. The study further revealed that small scale farmer in the study area operated at a relatively higher risk under the existing situation than would be the case under an optimal situation. Thus, the study suggested that the small scale farmers should allocate resources optimally not only to increase cash income but also to reduce risk.

Thomas et al., (1972) used separable programming for selecting farm enterprises which were efficient in terms of expected income and income variance. Estimates of income variances were used to incorporate risk into selection of enterprises on a representative farm unit in the Columbia basin of Washington. Under unlimited variance situation high income producing enterprises dominated the organization. Potatoes, sugar beets and cattle feeding, traditionally high income and high risk enterprises, were all at maximum levels permitted by production constraints. Profits for the farm were sensitive to the limitation on income variance. The most restrictive income variance situation reduced net farm income 15 per cent below the unlimited variance organization. This income reduction was largely the result of substitution of stable wheat for high risk potato production.

Dillon and Scandizzo (1978) used mind experiments involving choice between risky and sure farm alternatives to assess risk attitudes of samples of small farm owners and share croppers in Brazil. The results of the study indicated that most of the subsistence farmers were risk averters and risk aversion was more common and even greater among owners than share croppers. In an expected utility context, distribution of risk attitude coefficients (based on mean-standard deviation, mean variance and exponential utility functions) were diverse and not necessarily well represented by an average sample value. Econometric analysis indicated that income level and perhaps other socioeconomic variables influenced risk attitude.

Shahabuddin (1983) estimated the yield and price risk of different crops in some selected regions of Bangladesh. The variance-covariance matrices of random disturbances associated with both output and prices were estimated utilizing aggregate time series data in four districts. The general procedure adopted was to extract the systematic portion of aggregate time series so that the residuals represented the estimates of random components from which the relevant variance covariance matrices were subsequently computed. Ranking of crops in terms of estimated variance of output
disturbances showed that jute occupied the top position, followed by wheat, aman rice, aus rice, IRRIboro, oilseeds and pulses. Ranking of crops based on variances of output and price disturbances gave some idea of relative ‘yield risk’ and ‘price risk’ respectively.

Singh and Zilberman (1984) used both linear and quadratic programming for studying allocation of fertilizer among crops under risk in Punjab state. The results of this study led to two important conclusions that seem to have relevance for policy implications. First, the risk caused by price instability resulting in variation in income from the crop affected the allocation of land and fertilizer among the crops. Low risk crops associated with low levels of fertilizer were in the optimum cropping plans in place of high risk crops. Secondly, the existing land and fertilizer allocation pattern was away from the efficient expected income-variance (E-V) frontier. It implied that the existing plan was inefficient in the sense of minimum risk portfolio.

Bardsley and Harris (1987) developed a simple model relating the debt and asset portfolio of the farm in the production decision, which leads to a small non-linear system of equations. The system was estimated with time series and cross-sectional data from Australian broadacre agriculture using non linear three stage least squares. This gave a new method of estimating risk aversion coefficients by using actual behavior of farmers in a realistic economic environment rather than games played in artificial situations. Australian farmers were found to be risk averse, and the partial coefficient of risk aversion decreases with wealth and increases with income. The results were consistent with the results of studies by Binswanger (1981) in India using a completely different method. The coefficient of partial risk aversion estimated for Australian farmers was somewhat lower than the estimates reported by Binswanger for India, but this was not surprising given the differences in wealth, culture and capital market access and the completely different methods used. In fact, it was surprising that the estimates were of the same order of magnitude for such different groups.

Turvey et al. (1988) evaluated the systematic and non systematic risks as risk measures in farm planning models. A diagonal quadratic programming model based upon a single index model yielded farm plans similar to the full variance-covariance quadratic programme with four of thirteen farm plans being identical. Surprisingly a linear programming model using only systematic risk produces farm plans that are
identical to the full variance-covariance quadratic programme for eleven of thirteen income levels. Accordingly, it was suggested that single index based programming models may prove to be a practical alternative for deriving mean-variance efficient farm plans.

Ramaswami (1992) analysed the impact of production risk on a producers optimal input decisions. Whether producers use more or fewer inputs in a yield-risky environment depends on the sign of the marginal risk premium, which is determined by risk preferences and technology that is sufficient to sign the marginal risk premium for all risk averse preferences is presented. If this condition fails to hold, the marginal risk premium is not on the same sign for all risk averters. The study presented an empirical example which used data for the period 1921-57 from the Mississipi Agricultural Experiment Station on maize and cotton yield response to seven levels of nitrogen application to assign the marginal risk premium for decision makers with various degrees of risk aversion.

Risk associated with the adoption of new maize technology and the impact of mandatory cotton production on 140 traditional farmers surveyed in the Kasai Oriental region of Zair over the period 1981-86 were evaluated by Ames et al., (1993) using a quadratic programming model. Seasonal net returns for farm plans including four levels of maize technology in combination with staple food crops were evaluated, with and without mandatory cotton production. The results indicated that cropping system that include new maize technology were risk efficient relative to local maize varieties with mandatory cotton production was not risk efficient at the prevalent price and yield levels in the farming system.

Berbel (1993) proposed a multi- criteria approach for dealing with risk when modeling an agricultural system through simultaneous use of risk and game theoretic programming. The use of multi-criteria technique enables the decision maker to study the trade offs and conflicts between profitability (expected returns) and risk (measured either by partial absolute deviation or minimum gain). This research suggested that in practice the solutions generated by risk and game theoretic programming are quite similar. A by-product of this research has been to classify the relationships between stochastic efficiency and target MOTAD and game theoretic efficient sets.

Bhardwaj and Mahajan (1994) measured risk as a variability in the gross
margins which is a product of yield and price. The study revealed that yield is the major source of risk in the crop production. In Alwar district of Rajasthan the oilseed and pulse crops witnessed larger variation in yield during the period 1966-1980, the same had reduced during 1981-91 period. The risk averse behavior of farmers among different categories shows that the small farmers were high risk averse as compared to medium and large farmers in the investment decisions.

Kalirajan and Shand (1994) used the stochastic frontier production function to empirically measure the influence of technical and allocative risks on production. Risk was seen as arising principally from imperfect knowledge, first of best practice/techniques of the selected technology, which was termed as the allocative risk. Frontier production function was applied to a sample of farmers using a high yielding variety of cotton in Tamil Nadu, India. It was found from the estimation that the sample farmers had not achieved their potential outputs on their frontiers. Their mean economic efficiency with technical and allocative risk was 68.3 per cent. On an average, about 20 to 25 per cent of economic efficiency appears to have been lost by the sample farmers owing to their perceived technical risk. Similarly, about 6 to 7 per cent of economic efficiency seems to have been lost owing to their perceived allocative risk. Thus the results of this study suggested that the elimination of both risks with better information on best practices and market conditions has the potential of sustainability raising output and profits for the large majority of farmers.

Jha (1996) used a MOTAD (minimization of total absolute deviation from mean) to develop risk efficient farm plans for various size groups of farms in Kurukshetra district of Haryana. The model considered risk as negative deviation from mean and minimized it. The study indicated that shares of remunerative but risky crops viz. basmati paddy, potato and sugarcane decreased in the alternative risk efficient plans. The most notable feature of the risk efficient plans was the constant number of dairy animals across all plans. If emphasized the role of dairy in providing stable farm return.

In assessing the risks faced by producers, it is important to keep in mind that aggregated data can be misleading by underestimating the farm-level production risk. Indeed, a favourable yield in one location is typically offset by an unfavourable yield in another location, leading to lower yield variability at the aggregate level than at the farm
level. This spatial aggregation bias is much smaller for price variability since the spatial integration of output markets equalizes output prices across locations (OECD, 2010).

Asfaw, Mithöfer, and Waibel (2010) examined the factors influencing the adoption of the European Union (EU) private quality standards (EurepGAP) by small scale vegetable farmers in Kenya and the impact of EurepGAP adoption on household income. Using data from a survey of small-scale vegetable farmers in Kenya and a probit regression they identified the factors influencing adoption of EurepGAP among small-scale vegetable farmers. They found that access to information, capital, services, and availability of labor had a significant influence in farmers’ ability to adopt EU private food safety standards and therefore their ability to access developed country markets.

A study on estimation of economic returns to soil and water conservation research- an ex ante analysis reported that the economic surplus analysis has revealed that when adopted on a large scale, soil and water conservation technologies generate significant economic surplus as reflected in high NPV and BCR. The share of producer surplus has been found to be higher in the total economic surplus generated from technology adoption. Thus, investments in generation and transfer of soil and water conservation technologies have been found be justified in terms of economic benefits. However, various constraints that hamper adoption of these technologies are to be addressed so that the potential benefits could be realized by both farmer and consumer. (Rao et al., 2010).

Kersting and Wollni (2011) evaluated the factors influencing the adoption of GlobalGAP by fruit and vegetable farmers in Thailand. Global GAP is a worldwide standard that assures the use of Good Agricultural Practices (GAP) by producers all over the world. Using data from a survey of Thai fruit and vegetable farmers conducted in 2010 and a bivariate probit regression that accounted for potential sample selection bias, Kersting and Wollni identified farmer age and education, household wealth, farm size, farm labor availability, intensity of irrigation use, number of agricultural trainings attended, and support by exporters on the Global GAP adoption as factors influencing the adoption of GlobalGAP certification by Thai vegetable farmers.

Boys (2013) presents results from a study evaluating small and medium scale (SMS) producer motivations and barriers to purchase food product liability insurance.
This study involved an electronic survey of 256 SMS specialty crop farmers in the U.S. Southeast region including states from Virginia to Texas. About 38 per cent of the survey respondents indicated they had food product liability insurance. Concerns with liability, buyer requirements, and interest in improving marketing strategy (e.g., adding value, firm reputation, differentiation of product) were identified as motivations behind the decision to purchase food product liability insurance. Benefits associated with the adoption of food product liability insurance identified by respondents include: increased access to markets, decreased litigation concerns, improvement of firm reputation, and increased ability to participate in today’s business environment.

2.3.2 Optimization of resource use

In the Indian farming conditions, a number of studies have attempted programming approach to optimize the resource use and thereby developing optimum plans. Most of the studies used linear programming technique to develop optimum plans out of the existing ones fulfilling the desirable objectives. Some modifications were also tried by a number of researchers over the linear programming technique to suit the demand of their studies. Here attempts have been made to review some of the important works done during the last twenty five years in India and abroad regarding the development of optimum farm plans through optimization of resource use.

Agarwal and Kumawat (1974) studied the capital and credit requirements under existing and improved levels of technology for three different farm sizes in Jaipur district of Rajasthan state with the help of linear programming technique. They observed that per acre capital requirement for improved level of technology in the study area was 43 per cent higher than the actual farming situation. In regard to per acre credit requirement, it accounted for about 7 per cent increase. They further pointed out that the organizational as well as technological changes would significantly increase the capital and credit requirements for all size of farms. Credit requirements were expected to increase further with the change in technology.

Sani and Sidhu (1975) analyzed the capital and credit requirements for three synthetic farm situations with and without dairy enterprise at the existing and improved levels of technology through the use of linear programming technique. They observed that introduction of dairy enterprise at improved level of technology led to tremendous increase in the capital and credit requirement of the farmers.
Calkins (1981) applied linear programming model to a subsistence Nepalese farm maximizing income for better nutritional adaptation. They observed that the area under crops with high nutritional value increased when the nutritional aspects in the maximizing income had been considered in the linear programming model. Lazzari and More (1985) also opined in favour of linear programming technique to measure efficiency as a short term decision making tool.

Pandey and Gangwar (1982) reported that to suit varying situations linear programming models could be modified by allowing substantial flexibility in the resource constraints for deriving optimum production plans for the individual farm firms as well as for the area/region as a whole. For this purpose, the preparation of a detailed qualitative and quantitative inventories of various farm resources and other personal, social, institutional and market constraints (existing as well as the potential production processes along with their input-output coefficients) formed the very first step in exploring the alternatives and the possibilities for the modernization of agriculture in the concerned region. By using the partial budgeting technique, input-output coefficients of various alternative production processes could be synthesized and whenever required, benefit cost analysis could also be carried out for identification of suitable capital investment projects for modernization of agriculture.

Atteri and Joshi (1983) used the linear programming technique to examine the optimum allocation of resources and capital and credit requirements for small and marginal farmers in the Union Territory of Delhi. They reported that augmenting capital on the marginal and small farms through increased provision of credit at reasonable rates of interest helped them in adopting improved technology and thereby increased their productivity and made them economically viable.

Singh and Jain (1983) used a parametric linear programming (PLP) model to develop normative plans for sample farms in Ludhiana district of Punjab. The analysis has clearly indicated the high degree of risks involved in the existing plans of the farmers of each of the synthetic farm size situations. It has been shown that the profit maximizing normative plans which abstract from risk considerations are slightly less risky than the existing plans but are still dangerous from the risk angle compared to risk efficient plans.

Puhazhendhi (1987) used an alternative method of solving sequential stochastic
programming problem originally outlined by Cocks (1968), Hazell (1970) and Rae (1971) to derive sets of alternative farm plans under varied risk levels in different farm situations to discuss the risk management mechanisms that could be suggested for different farm situations. The risk levels of farms was measured by comparing the in the average income and reduction in the minimum income between maximized minimum income and maximized average income solution. The normative plans derived through the model indicated that there existed considerable scope to improve the efficiency of the existing plan by changing the cropping pattern. The study further indicated that restricted credit had resulted in greater reduction in net income under risk condition than under the normal situation and the restricted credit resulted in a shift from commercial crops to food crops.

Oberoi et al. (1988) while trying for optimization of cropping pattern on tribal farms in Himachal Pradesh used a linear programming model to suggest optimum plans under varying levels of technology. The optimum farm situations were examined separately for irrigated as well as rainfed farms, which included (i) existing technology and resources in the base period, (ii) improved technology with existing resources and (iii) improved technology with a provision for augmenting the existing resources with hired labour and borrowing of capital. Various real activities were included in the model to fulfill the objectives of the study. The farm incomes from optimal solutions were worked out to be `3924, `4804 and `5301 under the situations (i), (ii) and (iii), respectively.

Sankhayan et al., (1988) used a multiple objectives programming (MOP) model for developing optimum cropping plans for a typical Punjab farm. The MOP model developed dealt with five objectives namely, maximization of gross margins and family labour employment and minimization of borrowing for working capital, human labour hiring and variability of labour use over different quarters in a year. A set of farm plans have been developed by giving varying weights to different objectives while using compromise programming (C.P.) as a technique of multiple objectives farm planning. Before this Romero et al., (1987) also used CP in solving an MOP farm planning problem with the conflicting objectives of a cooperative in Andalusia, Spain. They attempted to find a best compromise among gross margins, seasonal labour and employment while selecting from a large set of Pareto-Optimal farm plans.
Linear programming technique was also used by Sinha and Sharma (1988) for optimization and to assess the impact of credit and technology on income and employment. From their study they concluded that there was scope for increasing farm income and labour employment in the project area, if the available resources were merely reorganized optimally.

Barman (1990) used a deterministic linear programming model as an analytical tool for optimizing resource use for various size groups of tribal and non-tribal farms in Nalbari district of Assam. The results of this study pointed out that even in the existing plans; there remained further scope of increasing net returns. Effect of optimization on cropping pattern, labour employment and net return were studied with the provision of minimum area, capital borrowing, labour hiring and FYM purchasing activities.

Chaudhary and Chaudhary (1992) investigated the possibilities of increasing net farm income by including labour intensive dairy enterprises and vegetables along with crops under existing levels of technology in Pakistan. Linear programming was used to determine the optimum allocation of resources and combination of activities on farms. Activities were those of producing crops and livestock augmenting resources, namely, hiring additional labour, consuming wheat and paddy produced on the farm and selling surplus quantity of produce. Results were obtained on the optimum and feasible numbers of buffaloes and optimum cropping patterns. It was concluded that increased cash returns can be achieved by mixed farming even with subsistence food restrictions through efficient resource allocation and improved marketing practices.

Sen and Dubey (1994) used a ‘multi objective programming’ (MOP) approach as a measure of resource use planning for Kerakat block of the Jaunpur district in eastern Uttar Pradesh. Three alternative plans viz. Plan I (income maximization), Plan-II (employment maximization) and Plan-III (multi-objective optimization) were formulated. The plan-III was considered best among all because it gave the compromised results. Income under this plan though was slightly less than the plan-I but was quite higher than that under plan-II. Similarly, the employment generated under this plan was slightly less than Plan-II but was higher than that under Plan-I.

Singh (1994) examined the prospects of increasing net farm income in Hazaribagh district of Bihar, on different categories of farms, by the use of profit maximization model of linear programming technique. Two optimal plans, yielding
about double and triple net income over the actual base period plan, were developed to fulfill the objectives of getting maximum possible net income. The study revealed that no additional inputs were needed for these optimal plans even under best available technology. Further there existed a large potential for increasing the net farm income by mere reallocation of existing resources in the farm of optimum crop mix.

Bhalet al., (1996) used the risk evaluation model developed by linking it up with a linear programming model to work out the income variances in the optimum farm plans and further the modified solution with lower income variance has been developed for different agroclimatic zones of Himachal Pradesh. The findings of this study revealed that the standard deviations in the alternate plans reduced to the extent of 9.16, 0.72 and 13.70 per cent for Kangra, Mandi and Shimla, respectively. However, the total gross income in the alternate plan also declined over the respective optimum farm plans which can be attributed due to the fact that the crops having higher income also have the higher income variance.

Jha (1996) used a profit maximizing linear programming technique for three synthetic farm situations of small, medium and large farms in Kurukshetra district of Haryana. Resources were optimally allocated with existing capital availability (Plan-A) and also with unlimited medium term dairy capital (Plan-B). The effects of optimization on land, labour and capital utilization were studied by comparing plans-A and B, with the existing plans. The study indicated that there existed sufficient scope restructuring the existing wheat-paddy cropping system with basmati paddy, potato, sugarcane, sunflower and summer pulses. However, profitable levels of these crops were restricted due to market imperfections prevalent in the area. The study highlighted the role of dairy enterprises in enhancing the income and employment on small farms.

The linear programming models with certain modifications were used by most of the researchers to develop optimum farm plans. Efforts were made by few researchers such as Turvey et al., (1988) and Bhalet al., (1996) to link up risk evaluation models with the linear programming models. Zia (1998) used compromise MOTAD programming techniques together with riskplanning methods for developing the best compromise farm plans in Pakistan. Compromise farm plans furnish very useful information on resource allocation and risk. Through the present extension networks, the model can be applied to improve resource use efficiency. It can also be utilised for
assessing environmental costs in agriculture with little adaptation.

Typically, agricultural production is a risky business since farmers are faced with uncertainties in most of their production plans and decisions. Farmers recognize a variety of input and output prices, variability in yields due to climatic and biophysical factors in their immediate environment, as well as resource risks all of which determine their production possibilities and optimal resource allocation decisions (Bruce and McCarl, 1998).

Agricultural production is typically a risky activity and agricultural risks impose a burden to small scale farmers especially in developing countries. This is because small scale agriculture is practiced in a risky environment associated with variability of the biophysical factors of production and market prices. Farmers therefore are confronted with volatile input and output prices and variable yields, which influences both their production possibilities and optimal farm plans (Olarinde et al., 2008).

The linear programming model is one of the widely used mathematical techniques in agriculture planning. The model has been used for maximisation of production of crops (Arnold and Bennet, 1975) and for minimizing costs to a farmer both constrained and unconstrained conditions by Adejobi et al. (2007). The same analytical tool was also employed by Ayhonlah et al. (2009) in his analysis on the optimal arable crop plan and child farm labour reduction in rural households of Ogun state of Nigeria.

The above discussion on review of literature highlights that risks is an important element in the agricultural production process and risk management strategies have been important as far as minimization of risks are concerned. The linear programming model with suitable modifications as an analytical tool have been used by most of the researchers for developing crop production optimization plans in different situations.