CHAPTER V

SUMMARY AND CONCLUSION

5.1 SUMMARY AND CONCLUSION

The present study was designed to analyse the crop production risks and measures adopted by the farmers of riverine areas in the Upper Brahmaputra Valley Zone (UBVZ) of Assam with the three main objectives (i) To study the factors influencing risks associated with crop production in the riverine areas of Upper Brahmaputra Valley zone (ii) To measure the quantum of risks and various risk minimization strategies adopted by the farmers (iii) To suggest appropriate risk minimization crop production plans for the farmers of the study area.

Risk refers to situations where parameters (such as mean-variance) of the probability distribution of outcomes can be empirically estimated and uncertainty on the other hand, refers to those situations in which the parameters of the probability distribution of outcomes cannot be empirically estimated. Agricultural production is subjected to more risks and uncertainties than industrial production. There are normally three types of variability in crop production process viz. yield variability, price variability and income variability. Yield variability is due to pest and diseases, unfavourable weather conditions and poor crop management. Price variability occurs due to changes in market supply and demand situations. Both input and output prices are changing over years. Income variability is the result of variations in input-output prices and crop yield. A negative correlation between price and yield is an important feature of agricultural production, which helps in stabilizing farm income. Prices tend to be high when production is low and they tend to be low when production is high. Stabilizing prices in this situation can actually raise farm income instability. Market level analyses and the study of price policy are required to help design price policies that enhance farm income stability.

The study of risk basically consists of two aspects: risk analysis and risk management analysis. Risk analysis consists of the study of the nature, magnitude, and sources of risk and how technology affects these characteristics. Risk management, on the other hand, involves the use of methods that reduce risk and its impact. Even if a technology is risky, farmers may adopt it if adequate means for diffusing risk are
available. Risk could be studied at the micro (or farm) level or at the macro (region or nation) level. The purpose of farm-level analysis is to study adoption decisions in the face of risk. Macroeconomic parameters are assumed to be given and farmers’ responses to risk are studied. In the case of macro analysis, the purpose is to study the implications of fluctuating production for food security at the regional or national level. Although farmers may adopt improved technologies because they are profitable, the instability of production at the aggregate level may increase as a consequence. Appropriate technological and policy interventions are required to reduce such adverse effects on food security.

Farmers’ risk-coping strategies may be classified into ex ante and ex post, depending on whether they help reduce risk or reduce the impact of risk after a production shortfall has occurred. Because of the lack of efficient market-based mechanisms for diffusing risk, farmers modify their production practices to provide “self insurance” so that the chances of negative consequences are reduced to an acceptable level. Ex ante strategies help reduce fluctuations in income and are also referred to as income-smoothing strategies. These strategies can be costly, however, in terms of forgone opportunities for income gains as farmers select safer but low-return activities. Ex ante strategies could be grouped into two categories: those that reduce risk by diversification and those that do so through greater flexibility. Ex post strategies are designed to prevent a shortfall in consumption when family income drops below what is necessary for maintaining consumption at its normal level. They are also referred to as consumption-smoothing strategies as they help reduce fluctuations in consumption even when income is fluctuating. These strategies include consumption loans, asset liquidation etc. Farmers who are exposed to risk use these strategies in different combinations to ensure survival. Over a long period of time, some of these strategies are incorporated into the nature of the farming system and are often not easily identifiable as risk-coping mechanisms.

In Assam out of 30.16 lakh ha of cultivable land, about 0.38 lakh ha is affected by siltation and about 4.93 lakh ha of area is chronically flood prone. Soil degradation due to erosion and the depletion of ground water resources are two major environmental problems threatening agricultural production and productivity in the riverine belt of Assam. The riverine belt is spread over as the alluvial land forms on the recent flood
plain of the river Brahmaputra and its perennial tributaries. These are the riverine land forms and river islands that are periodically formed and eroded due to meandering, braiding and the changing course of the rivers. The riverine area known popularly as char and chapori land therefore is subjected to high crop production risks. The state has about 2.42 lakh ha (8% of total cultivable land of the State) such land which is cultivable out of 3.60 lakh ha of riverine area. The riverine areas are an integral part of the very complex fluvial regime of the Brahmaputra river. In Assam, the river flows through a highly braided channel with numerous lateral and mid-channel bars, i.e. riverine area.

Agriculture is the main sources of living for the people living in riverine area, about 95% people, depend on agriculture directly or indirectly. They cultivate mainly rice, jute, maize, pulses, mustard seeds and different types of vegetables. However, due to number of social, economic, political and institutional factors, half of the people living in riverine area are below the official poverty line. Nearly 85% of the people inhabiting in riverine areas are Muslims. Assam Agricultural University (Jorhat, 1986) Committee on Development of Agriculture in Riverine Areas reported that most of the people living in the riverine areas excepting the riverine areas of Majuli were immigrant Muslims from erstwhile East-Bengal. The river Brahmaputra is passing through the entire Brahmaputra valley from east to west flowing a distance of nearly 450 km. Along its course the mighty river has been creating innumerable islands and dried-up alluvial land due to frequent change in its course. These river islands and dried up alluvial land are known as riverine area or char-chaporis. The local people of Assam did not feel it necessary to occupy these riverine areas as fertile land was available in their neighbourhood far away from the river. The large number of migrant people started settling down occupying these riverine areas of Brahmaputra valley. At first the immigrants settled in the riverine lands besides the river banks but gradually extended to other places of the Brahmaputra valley. Thus, a population of nearly 25 lakhs (2002-03) coming from different districts of East-Bengal have settled in the char areas of 14 districts of this valley. This huge group of population constitutes nearly 10% of the total population of Assam. They are still living in riverine area of Assam isolated from main land. These people are, in general, poor, illiterate, conservative, prone to flood, disease, health problem.
In the context of the problems being faced by the farmers of the riverine areas, it is considered imperative to analyse, plan and suggest an appropriate risk minimization crop production plans for the farmers of the riverine areas in the state. Not much studies have been conducted covering the riverine areas in the state so as to suggest measures to the farm planners and policy makers. The upper Brahmaputra Valley zone of the state is selected considering the convenience of the researcher and also due to the availability of the world’s largest riverine island “Majuli”. The Upper Brahmaputra Valley (UBV) zone of Assam comprised of the districts of Sivasagar, Jorhat, Golaghat, Dibrugarh and Tinsukia with a geographical area of 16,192 sq.km. The topography slopes down gradually from the hills towards the Brahmaputra. The mighty river Brahmaputra has got half a dozen important tributaries. These tributaries start in the hills of Nagaland and Arunachal Pradesh and traverse the zone rapidly to join in the Brahmaputra. The riverine areas are therefore very common across these tributaries along with the main river Brahmaputra. The climate of the zone is characterized by high rainfall, i.e., more than 2000 mm per annum and high humidity (more than 80%). The physiography of this zone has different characters and demographic units like active flood prone plains, younger alluvial plain, older alluvial plain, structural valley and hills. Ground water is available at shallow depth in flood prone plain and younger alluvial plain areas and at greater depth in older alluvial areas. In the zone total cropped area is highest in Jorhat district and it is lowest in Dibrugarh district.

A multistage stratified random sampling technique was used to select the ultimate sample unit. The present study was designed to analyse the crop production risks and measures adopted by the farmers of riverine areas in the Upper Brahmaputra Valley (UBV) zone of Assam. The Upper Brahmaputra Valley zone of Assam comprised of the districts of Sivasagar, Jorhat, Golaghat, Dibrugarh and Tinsukia with a geographical area of 16,192 km². In the first stage two districts viz. Jorhat and Dibrugarh were randomly selected. In the second stage the riverine areas within the district were identified and three blocks that had riverine areas within its jurisdiction from each district were selected. In the next stage block wise list of villages was prepared and two villages were selected randomly from each block. Thus a total of six blocks and twelve villages were selected from the two districts of Upper Brahmaputra Valley Zone of Assam. Village-wise list of farmers was prepared and the farmers were
categorised into four size groups that is small (upto 2 ha), medium (2-4 ha) and large (above 4 ha). For deriving the results of this study both primary as well as secondary data have been used. The primary data necessary for the study were collected from the selected sampled farmers through well structured and pre-tested schedules. For recording data, each of the selected farmers was personally interviewed. The primary data collected from the sampled farmers comprised of the general information regarding the inventory of farm resources, input-output coefficients for various crops, prices of inputs and outputs and packages of practices in the cultivation/production of various crops/farm products and quantum of crop damages due to various factors and farmers perceptions towards various risks involved in crops production. All primary data along with data on farmer’s expected level of return from each and every farm enterprise were recorded carefully. The primary data collected pertained to the period 2013-14. The secondary data regarding area, production and productivity of selected crops were collected from the Economic Survey of Assam (various issues), publications of Directorate of Agriculture, Assam, District offices of the State department of Agriculture etc. The zonal level aggregate data have been computed from the district level data compiled for the period 2003 to 2012.

Important crop enterprises grown in the study area were identified and included in the study. The selected crops are (1) autumn rice (2) winter rice (3) summer rice (4) green pea (5) potato (6) pumpkin (7) green gram (8) brinjal (9) rapeseed (10) okra (11) black gram (12) cabbage (13) cauliflower (14) sugarcane and (15) chilli. Factors influencing crop production risks in the riverine areas are identified and listed based on farmers perception. The mean values for the risk sources or factors influencing risk in crop production are calculated. The mean values are calculated by assuming that these factors together are responsible for 100 per cent of crop damage in the study area. To measure the quantum of risks associated with the yields of major activities in the study area, coefficient of variation (CV) was used and ranked them in descending order. As time series farm level data on area, production and productivity were not available some alternative procedure had to be followed. It was assumed that aggregate district level data reflected the yield variations at the farmers’ field levels. The risk management strategies adopted by farmers in the riverine areas are identified and listed based on farmers’ perception. The mean values for the risk management or minimization
strategies for crop production adopted by farmers are calculated. The mean values are calculated by assuming that these strategies were responsible for minimization of 100 per cent risk in the study area.

To suggest appropriate risk minimization crop production plans for the farmers of riverine area in the Upper Brahmaputra Valley Zone (UBVZ) of Assam, MOTAD (Minimisation of Total Absolute Deviation) MODEL was used in the study. The input-output coefficients for the technological matrix were comprised of the resource requirements, output produced per unit of activity and its absolute value of the negative deviation from the expected return per unit of the activity included in the programme. The input-output coefficients of various activities considered for deriving the synthetic plans for all the size groups of farms were obtained by averaging the collected data of the selected farms, as it has been assumed that the best estimate of input-output coefficients would be the average input-output coefficients obtained from the sampled farms.

In the programming model constraints mainly pertaining to land, labour, capital resources and minimum area requirement were used along with the crop area and capital flexibility constraints. Land was also classified into three distinct categories which were termed as upland, medium land and low land. Again upland, medium land and low land were categorised under summer season, kharif season and rabi season. Thus land was classified into 9 different types viz., summer upland, summer medium land, summer lowland, kharif upland, kharif medium land, kharif lowland, rabi upland, rabi medium land and rabi lowland.

The month wise availability of human labour units were recorded and finally the availability of human labour units were estimated for each season for inclusion in the programming model. Three capital constraints were used for three seasons in the programming model. In order to ascertain the total capital availability, both owned plus borrowed capital with interest charges were taken into consideration. The minimum area restriction has been imposed to autumn rice, winter rice and summer rice only as rice is the major crop in the study area and staple food for the people of Assam. The objective function of the programming model was defined by dual criteria of parameterization of expected return and minimization of risk associated with the expected return.
In the study area rice (31.08%) is the major crop followed by summer vegetables (24.44%), rabi vegetables (15.81%), pulses (13.01%), potato (5.23%), sugarcane (4.65%), oilseeds (3.40%) and chilli (2.38%). Altogether 17 risk sources or factors influencing crop production risks were identified and examined for three different size groups of farmers based on farmers’ perception. The mean values for the risk sources influencing agricultural crop production were also calculated. The mean values were calculated by assuming that these factors were responsible for 100 per cent of crop damage in the study area. Calculated mean values revealed that flood and excessive rainfall (49.43%) was the most important risk factor for the three groups of farmers in the study area followed by soil erosion (12.29%). The other influencing factors were insufficient rainfall (9.17%), pest and diseases (5.41%), government involvement and agricultural policy (4.24%), input costs (3.42%), insufficient machinery (2.53%), insufficient family labour and difficulties in finding labour (3.40%), lack of contract growing (2.05%), interest rates and debt situation (1.47%), inadequate financial condition (1.24%), health problem (1.10%), climatic conditions (1.11%), lack of farm record keeping (0.97%), thieving (1.49%), crop prices (0.41%) and crop yields (0.27%).

In the study area, chilli (x16) is the most important risky crop followed by rapeseed (x10), black gram (x12), potato (x6), green pea (x3), ahu HYV (x1), boro rice (x5), sali local (x4), sali HYV (x2), brinjal (x9), pumpkin local (x7), sugarcane (x15), okra (x11), cauliflower (x14), cabbage (x13) and green gram (x8). The calculated values of coefficient of variance (C.V.) for chilli (x16) rapeseed (x10), black gram (x12), potato (x6), green pea (x3), ahu HYV (x1), boro rice (x5), sali local (x4), sali HYV (x2), brinjal (x9), pumpkin local (x7), sugarcane (x15), okra (x11), cauliflower (x14), cabbage (x13) and green gram (x8) in the riverine area of Upper Brahmaputra Valley Zone of Assam were 33.3339 per cent, 22.3304 per cent, 21.0517 per cent, 19.574 per cent, 17.3296 per cent, 15.3818 per cent, 14.8274 per cent, 14.4852 per cent, 12.7476 per cent, 11.57362 per cent, 7.1872 per cent, 5.832 per cent, 5.6216 per cent, 5.432413 per cent, 1.58902 per cent and 0.372 per cent. Positive relationship between coefficient of variation and income was among three groups of farmers i.e. with higher incomes, risk is also higher, when the income is reduced, the associated risk is also reduced.

Altogether 18 risk management strategies were listed out of which 17 strategies were followed by the farmers of the study areas. Some of these risk management
strategies were ex ante i.e., before the occurrence of the risky event viz., either flood or drought and some of the measures were ex post i.e., these strategies were adopted after the occurrence of the risky event in the farm. The important ex ante strategies followed were growing more than one crop, growing more than one variety, adjusting the sowing time to avoid the risky period and avoiding high risk farm land particularly very low land to avoid complete damage during flood. Some of the important ex post strategies adopted were forced sale of household assets, doing non-farm works etc. Some of the strategies were adopted as risk coping mechanism as and when the situation occurred such as drainage to drain out excess water during heavy rainfall, providing life saving irrigation during drought, bunding and mulching for preserving water and soil moisture.

The mean values were calculated by assuming that these strategies together were responsible for 100 per cent of management/minimization of crop production risk in the study area. Calculated mean values for various risk minimizing strategies indicated that the most effective risk management strategy in the study area was growing more than one crop (10.11%) followed by bunding (9.43%), manure and fertilizer application (8.42%), spraying and drenching of pesticides (8.30%), irrigation (8.30%), drainage (8.30%), interculture operation (8.29%), growing more than one variety (7.81%), plant growth regulator (4.54%), planning expenditure (4.37%), doing non-farm works (4.33%), avoiding high risk farm land (3.40%), ITK (3.18%), managing resource use (3.12%), reducing debt burden (2.92%), keeping farm record (2.74%) and contract growing (2.44%). Crop insurance which is generally considered as an important risk minimizing strategy was not prevalent in the area and not a single farmer was found to have undertook crop insurance in the riverine areas.

Typical farm situation was considered for the construction of programming matrix. The farm size was divided into three groups as small (≤ 2 ha), medium (2-4 ha) and large (> 4 ha). Typical farm with farm size 1.92 has as small, 3.84 has as medium and 6.82 has as large were selected for applying the MOTAD model. Nine types of land restrictions were introduced (first summer upland, second summer medium land, third summer lowland, fourth kharif upland, fifth kharif medium land sixth kharif lowland, seventh rabi upland, eighth rabi medium land and ninth rabi lowland). Human labour availability in the summer, kharif and rabi seasons were entered separately as three constraints. Capital constraints were identified for three seasons and fixed as three
separate constraints. Besides, ten risk rows were entered to remove the negative deviation in realised income deviations during the past years.

The small farm of the study area has an average area of 1.92 ha and land is assumed to be homogeneous in fertility. Besides this, the small farm has the average availability of 0.94 ha of upland, 0.60 ha of medium land and 0.38 ha of lowland. Besides this restriction, the average small farm has the availability 360 man days of summer human labour, 360 man days of kharif human labour and 360 man days of rabi human labour. The small farm has also limitation of ` 60530.00 on summer working capital, ` 58760.00 on kharif working capital and ` 57780.00 on rabi working capital.

Ten optimal crop production plans were suggested for the three group farmers of the riverine area in the Upper Brahmaputra Valley Zone (UBVZ) of Assam. Plan- 1 is a risk minimum plan with lowest expected income while Plan- 10 is high risk plan with highest expected income. The existing production plan of the small size groups in the study area represents an yearly income of ` 223640.00 with the allocation of 0.15 ha (4.01% of total gross crop area) to ahu HYV paddy (x1), 0.46 ha (12.21% of total gross cropped area) to sali HYV paddy (x2), 0.10 ha (2.67% of total gross cropped area) to green pea (x3), 0.32 ha (8.56% of total gross cropped area) to sali local paddy (x4), 0.18 ha (4.81% of total gross cropped area) to potato (x6), 0.48 ha (12.83% of total gross cropped area) to pumpkin local (x7), 0.31 ha (8.29% of total gross cropped area) to green gram (x8), 0.24 ha (6.42% of total gross cropped area) to brinjal (x9), 0.20 ha (5.35% of total gross cropped area) to rape seeds (x10), 0.23 ha (6.15% of total gross cropped area) to okra (x11), 0.17 ha (4.54% of total gross cropped area) to black gram (x12), 0.21 ha (5.62% of total gross cropped area) to cabbage (x13), 0.20 ha (5.36% of total gross cropped area) to cauliflower (x14), 0.21 ha (5.61% of total gross cropped area) to jaggery (x15) and 0.10 ha (2.67% of total gross cropped area) to chilli (x16). The existing production plan of the average small farm has the cropping intensity of 194.79% with the availability of 3.74 ha of gross cropped area, 1080.00 man days of human labour, ` 177070.00 working capital with a Benefit Cost Ratio 1.26.
Optimal crop production plan- 1 of the small size groups in the study area suggest an yearly income of ` 227230.00 with the allocation of 0.10 ha (2.93% of gross cropped area) to *ahu* HYV (x1), 0.10 ha (2.93% of gross crop area) to *sali* HYV (x2), 0.10 ha (2.93% of gross cropped area) to *sali* local (x4), 0.10 ha (2.93% of gross cropped area) to *boro* rice (x5), 0.01 ha (0.27% of gross cropped area) to potato (x6), 0.39 ha (11.40% of gross cropped area) to pumpkin local (x7), 0.84 ha (24.06% of gross cropped area) to green gram (x8), 0.84 ha (24.06% of gross cropped area) to okra (x11), 0.84 ha (24.06% of gross cropped area) to cabbage (x13) and 0.10 ha (2.93% of gross cropped area) to sugarcane (x15). The plan 1 has the cropping intensity of 178.12% with the requirement of 3.42 ha gross crop area, 271.96 man days of human labour and ` 114381.47 of working capital. The plan 1 has a yearly gross margin of ` 112848.53 per ha with the gross margin per unit of working capital of ` 0.98 and BCR of 1.98.

On the other hand, optimal crop production plan- 10 of the small size groups in the study area suggest an yearly income of ` 272230.00 with the allocation of 0.10 ha (2.62% of gross cropped area) to *ahu* HYV (x1), 0.10 ha (2.62% of gross cropped area) to *sali* HYV (x2), 0.10 ha (2.62% of gross cropped area) to *sali* local (x4), 0.10 ha (2.62% of gross cropped area) to *boro* rice (x5), 0.60 ha (15.71% of gross cropped area) to pumpkin local (x7), 0.94 ha (24.61% of gross cropped area) to green gram (x8), 0.94 ha (24.61% of gross cropped area) to brinjal (x9), 0.83 ha (21.71% of gross cropped area) to cabbage (x13) and 0.11 ha (2.88% of gross cropped area) to cauliflower (x14). The plan 10 has the cropping intensity of 198.96% with the requirement of 3.82 ha gross crop area, 278.74 man days of human labour and ` 123190.151 of working capital. The plan 10 have a yearly gross margin of ` 149039.849 per ha with the gross margin per unit of working capital of ` 1.21 and BCR of 2.209.

The medium farm of the study area has an average area of 3.84 has and land is assumed to be homogeneous in fertility. Besides this, the medium farm has the average availability of 1.44 has of upland, 1.28 has of medium land and 1.12 has of lowland.
Besides this restriction, the average medium farm has the availability 230 man days of summer human labour, 228 man days of kharif human labour and 232 man days of rabi human labour. The medium farm has also the limitation of ` 83630.00 on summer working capital, ` 76920.00 on kharif working capital and ` 71740.00 on rabi working capital.

The existing production plan of the medium size groups in the study area represents an yearly income of ` 332175.00 with the allocation of 0.37 ha (6.34% of total gross crop area) to ahu HYV paddy (x1), 0.59 ha (10.10% of total gross crop area) to sali HYV paddy (x2), 0.33 ha (5.65% of total gross cropped area) to green pea (x3), 0.49 ha (8.39% of total gross cropped area) to sali local paddy (x4), 0.37 ha (6.34% of total gross cropped area) to boro paddy (x5), 0.28 ha (4.79% of total gross cropped area) to potato (x6), 0.51 ha (8.73% of total gross crop area) to pumkin local (x7), 0.43 ha (7.36% of total gross crop area) to green gram (x8), 0.31 ha (5.31% of total gross crop area) to brinjal (x9), 0.34 ha (5.82% of total gross crop area) to rapeseeds (x10), 0.32 ha (5.48% of total gross crop area) to okra (x11), 0.26 ha (4.45% of total gross crop area) to black gram (x12), 0.37 ha (6.34% of total gross crop area) to cabbage (x13), 0.24 ha (4.11% of total gross crop area) to cauliflower (x14), 0.42 ha (7.19% of total gross crop area) to jaggery (x15) and 0.21 ha (3.60% of total gross crop area) to chilli (x16). The existing production plan of the average medium farm has the cropping intensity of 152.08% with the availability of 5.84 ha of gross crop area, 690.00 man days of human labour, ` 232290.00 working capital with a Benefit Cost Ratio of 1.43.

Optimal crop production plan- 1 of the medium size groups in the study area suggest an yearly income of ` 347410.00 with the allocation of 0.20 ha (3.47% of gross crop area) to ahu HYV (x1), 0.20 ha (3.47% of gross crop area) to sali HYV (x2), 0.31 ha (5.38% of gross crop area) to sali local (x4), 0.20 ha (3.47% of gross crop area) to boro rice (x5), 0.90 ha (15.63% of gross crop area) to pumpkin local (x7), 1.42 ha (24.65% of gross cropped area) to green gram (x8), 1.42 ha (24.65% of gross cropped area) to okra (x11), 1.09 ha (18.93% of gross cropped area) to cabbage (x13) and 0.02 ha (0.35% of gross cropped area) to cauliflower (x14). The plan- 1 has the cropping
intensity of 150.00% with the requirement of 5.76 ha gross cropped area, 431.36 man
days of human labour and `168841.36 of working capital. The plan 1 has a yearly gross
margin of ` 178568.64 per ha with the gross margin per unit of working capital of Rs
1.06 and BCR of 2.05.

On the other hand, optimal crop production plan- 10 of the medium size groups
in the study area suggest an yearly income of ` 392410.00 with the allocation of 0.20 ha
(3.24% of gross cropped area) to ahu HYV (x1), 0.20 ha (3.24% of gross cropped area) to sali HYV (x2), 0.20 ha (3.24% of gross cropped area) to sali local (x4), 0.20 ha (3.24% of gross cropped area) to boro rice (x5), 1.06 ha (17.15% of gross cropped area) to pumpkin local (x7), 1.44 ha (23.30% of gross cropped area) to green gram (x8), 1.44 ha (23.30% of gross cropped area) to brinjal (x9), 0.25 ha (4.04% of gross cropped area) to cabbage (x13) and 1.19 ha (19.25% of gross cropped area) to cauliflower (x14). The plan- 10 has the cropping intensity of 160.94% with the requirement of 6.18 ha gross
cropped area, 436.68 man days of human labour and ` 178089.62 of working capital.
The plan-10 have a yearly gross margin of ` 214320.38 per ha with the gross margin per
unit of working capital of ` 1.20 and BCR of 2.203.

The large farm has an average area of 6.82 has and land is assumed to be
homogeneous in fertility. Besides this, the large farm has the average availability of
2.64 has of upland, 2.06 has of medium land and 2.12 has of lowland. Besides this
restriction, the average large farm has the availability 220 man days of summer human
labour, 216 man days of kharif human labour and 224 man days of rabi human labour.
The large farm has also the limitation of `110200.00 on summer working capital, `105600.00 on kharif working capital and `101700.00 on rabi working capital.

The existing production plan of the large size groups in the study area represents
an yearly income of ` 447675.00 with the allocation of 0.58 ha (7.42% of total gross
cropped area) to ahu HYV paddy (x1), 0.94 ha (12.04% of total gross cropped area) to sali HYV paddy (x2), 0.39 ha (4.99% of total gross cropped area) to green pea (x3),
0.55 ha (7.04% of total gross cropped area) to *sali* local paddy (x4), 0.58 ha (7.42% of total gross cropped area) to *boro* paddy (x5), 0.34 ha (4.35% of total gross cropped area) to potato (x6), 0.56 ha (7.17% of total gross cropped area) to pumpkin local (x7), 0.51 ha (6.53% of total gross cropped area) to green gram (x8), 0.46 ha (5.89% of total gross cropped area) to *boro* rice (x5), 0.37 ha (4.74% of total gross cropped area) to rapeseeds (x10), 0.41 ha (5.25% of total gross cropped area) to okra (x11), 0.28 ha (3.59% of total gross cropped area) to cabbage (x13), 0.33 ha (4.23% of total gross cropped area) to black gram (x12), 0.59 ha (7.55% of total gross cropped area) to cauliflower (x14), 0.58 ha (7.43% of total gross cropped area) to chilli (x16). The existing production plan of the average large farm has the cropping intensity of 114.52% with the availability of 7.81 ha of gross crop area, 660.00 man days of human labour, 317500.00 working capital with a Benefit Cost Ratio of 1.41. The gross margin and gross margin per unit of working capital of existing production plan of the average large farm were 130175.00 per ha and 0.41 in the study area.

Optimal crop production plan- 1 of the large size groups in the study area suggest an yearly income of 462100.00 with the allocation of 0.30 ha (3.65% of gross cropped area) to *ahu* HYV (x1), 0.30 ha (3.65% of gross crop area) to *sali* HYV (x2), 0.30 ha (3.65% of gross cropped area) to *sali* local (x4), 0.30 ha (3.65% of gross cropped area) to *boro* rice (x5), 2.64 ha (32.07% of gross cropped area) to green gram (x8), 0.69 ha (8.38% of gross cropped area) to brinjal (x9), 1.52 ha (18.47% of gross cropped area) to okra (x11) and 2.18 ha (26.48% of gross cropped area) to cauliflower (x14). The plan- 1 has the cropping intensity of 120.67% with the requirement of 8.23 ha gross crop area, 539.60 man days of human labour and 224261.16 of working capital. The plan- 1 has a yearly gross margin of 237838.84 per ha with the gross margin per unit of working capital of 1.061 and BCR of 2.061.

On the other hand, optimal crop production plan- 10 of the large size groups in the study area suggest an yearly income of 507100.00 with the allocation of 0.30 ha
(3.55% of gross cropped area) to *ahu* HYV (x1), 0.30 ha (3.55% of gross cropped area) to *sali* HYV (x2), 0.30 ha (3.55% of gross cropped area) to *sali* local (x4), 0.30 ha (3.55% of gross
Table 5.1 - A comparison of Plan 1 among three groups of farmers of the riverine area in the Upper Brahmaputra Valley Zone (UBVZ) of Assam.

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<tr>
<th>Characteristics</th>
<th>Small Farm</th>
<th>Medium Farm</th>
<th>Large Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient of variation (C.V.)</td>
<td>15.6052</td>
<td>29.7515</td>
<td>46.5875</td>
</tr>
<tr>
<td>Exp. Income (')</td>
<td>227230.00</td>
<td>347410.00</td>
<td>462100.00</td>
</tr>
<tr>
<td>Cropping intensity (%)</td>
<td>178.12</td>
<td>150.00</td>
<td>120.67</td>
</tr>
<tr>
<td>Gross crop area (Ha)</td>
<td>3.42</td>
<td>5.76</td>
<td>8.23</td>
</tr>
<tr>
<td>Human labour (man days)</td>
<td>271.96</td>
<td>431.36</td>
<td>539.60</td>
</tr>
<tr>
<td>Working capital (')/ha</td>
<td>114381.47</td>
<td>168841.36</td>
<td>224261.16</td>
</tr>
<tr>
<td>BCR</td>
<td>1.98</td>
<td>2.05</td>
<td>2.061</td>
</tr>
<tr>
<td>Gross margin (')/ha</td>
<td>112848.53</td>
<td>178568.64</td>
<td>237838.84</td>
</tr>
<tr>
<td>Gross margin per unit of working capital (')</td>
<td>0.98</td>
<td>1.06</td>
<td>1.061</td>
</tr>
</tbody>
</table>

cropped area) to boro rice (x5), 2.64 ha (31.28% of gross cropped area) to green gram (x8), 2.42 ha (28.67% of gross cropped area) to brinjal (x9) and 2.18 ha (25.85% of gross cropped area) to cauliflower (x14). The plan 10 has the cropping intensity of 123.75% with the requirement of 8.44 ha gross crop area, 540.10 man days of human labour and 240387.48 of working capital. The plan-10 has shown a yearly gross margin of `266712.52 per ha with the gross margin per unit of working capital of `1.109 and BCR of 2.109.

A comparison between Plan- 1 and Plan- 10 among three groups of farmers of the riverine area in the Upper Brahmaputra Valley Zone (UBVZ) of Assam is shown in tables – 5.1 and 5.2.
Table. 5.2 - A comparison of Plan 10 among three groups of farmers of the riverine area in the Upper Brahmaputra Valley Zone (UBVZ) of Assam.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Small Farm</th>
<th>Medium Farm</th>
<th>Large Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient of variation (C.V.)</td>
<td>23.2014</td>
<td>43.2329</td>
<td>58.0651</td>
</tr>
<tr>
<td>Exp. Income (’)</td>
<td>272230.00</td>
<td>392410.00</td>
<td>507100.00</td>
</tr>
<tr>
<td>Cropping intensity (%)</td>
<td>198.96</td>
<td>160.94</td>
<td>123.75</td>
</tr>
<tr>
<td>Gross crop area (Ha)</td>
<td>3.82</td>
<td>6.18</td>
<td>8.44</td>
</tr>
<tr>
<td>Human labour (man days)</td>
<td>278.74</td>
<td>436.68</td>
<td>540.10</td>
</tr>
<tr>
<td>Working capital (’/ha)</td>
<td>123190.151</td>
<td>178089.62</td>
<td>240387.48</td>
</tr>
<tr>
<td>BCR</td>
<td>2.209</td>
<td>2.203</td>
<td>2.109</td>
</tr>
<tr>
<td>Gross margin (’/ha)</td>
<td>149039.849</td>
<td>214320.38</td>
<td>266712.52</td>
</tr>
<tr>
<td>Gross margin per unit of working capital (’)</td>
<td>1.21</td>
<td>1.20</td>
<td>1.109</td>
</tr>
</tbody>
</table>

In all the optimal plans indicate that in all the farm groups cropping intensities have increased across various plans and maximum cropping intensities were found maximum in the optimum plans-10 of medium and large farm size groups thereby indicating possibilities of covering larger areas in the optimal plans-10. In case of small farm size plans-6 and 7 indicated maximum cropping intensity of 202.60 percent. There have been reduction in areas up to zero level under the crop chilli and sugarcane in all the size groups of farms in the optimal plans. This was because these two crops were non remunerative considering the situation of the study area. Areas under cabbage, cauliflower, green gram and potato have also been reduced in the optimal plans due to riskiness as well as non profitability. The suggested risk minimization plans are considered feasible for the study area under the situation of resource availability and flexibility constraints.

5.2. POLICY IMPLICATIONS

Agricultural crop production system in the riverine areas of Assam is typically a risky business. Risk will continue to be an important factor for the farmers of the riverine area in the Upper Brahmaputra Valley Zone (UBVZ) of Assam. Several
Interventions are needed to reduce risk as well as its impact on farmers’ welfare. These interventions include both agricultural research and policy reforms. Research to develop improved varieties that have increased tolerance to various biotic and abiotic stresses must be strengthened. This may be achieved by

- Shortening the life cycle of cereal crops and reducing their sensitivity to seasonal signals such as daylength;
- Introducing hardness into crop varieties to enable them to withstand drought, cold, heat, and other climatic stresses;
- Incorporating genetic resistance to pests and diseases (Holden et al. 1991);
- Introducing “competitiveness” in varieties to enable them to survive in marginal environments; and
- Improving the physiological efficiency of the rice crop in a given agro-climatic condition.

Similarly, risk management strategies like growing more than one crop, bunding, manure and fertilizer application, spraying and drenching of pesticides, irrigation, drainage, intercultural operation including mulching, growing more than one variety (growing of flood tolerant variety like bao rice) and adjusting sowing time, use of plant growth regulator, planning expenditure, doing non-farm work, avoiding high risk farm land, managing resource use, reducing debt burden, keeping farm records and contract growing can minimize the risk for the farmers of the riverine area in the Upper Brahmaputra Valley Zone (UBVZ) of Assam to some extent. Introduction of crop insurance scheme by the government for the farmers of riverine area in the Upper Brahmaputra Valley Zone (UBVZ) of Assam is another important risk minimizing strategy.

More allocation of area to rabi vegetables like cabbage, cauliflower and summer vegetables like pumpkin local, brinjal can minimize the risk and maximize the income of the farmers in the riverine area. Cost-reducing strategies that focus on economizing and substituting for external resources must be implemented, bio-fertilizer and bio-pesticides can be used instead of synthetic fertilizers and plant protection chemical. Resource (soil and water) conservation and shifting to sustainable alternatives (natural farming, watershed management, biological methods of pest control and nutrient use)
can help reduce risk. Better agronomic management practices of crops is essential to facilitate rapid crop recovery of stress periods and to improve input use efficiency. The economics of such practices, however, needs careful evaluation. On the policy front, provision of special credit facilities to drought-prone and rainfed areas in the form of production and consumption loans may help farmers minimize the impact of risk. Development of labor-intensive technological packages for lagging riverine areas and crops supported by land reform would strengthen farmers’ ability to manage risk. Other risk management methods that require policy support include maintaining food buffer stocks, food subsidies, relief employment, and food for work programs (Hazell 1986, Rao et al 1988). Price stabilization schemes and financial innovations such as commodity-linked financing (as a hybrid instrument) can similarly help to reduce risk.

Agriculture is the main source of income for the people living in riverine areas of Upper Brahmaputra Valley Zone (UBVZ) of Assam. So, it is important that agriculture be put on top of the policy agenda. A two-pronged policy intervention is needed, one at the institutional level and the other at the household level. A people-government partnership, on an enduring basis, is a must for these areas. Once agriculture improves, the nonagricultural segment of the local economy would improve as well.

The expansion of irrigation and the development of varieties suitable to the environment of riverine areas in the Upper Brahmaputra Valley Zone (UBVZ) of Assam are likely to be the causal factors that have reduced instability and increased growth simultaneously. Plant breeders, Bio-technologist and others involved in technology development may be more successful in increasing and stabilizing crop production by focusing on strategies to increase the average yield. The rice production system of Assam is characterized by high levels of flood risk and low yields. Productivity of autumn rice is low and technologies are needed to improve its average yield. As the crop generally suffers from flood during its later growth stage, use of shorter duration varieties that mature before floods arrive can reduce risk. Similarly, the early establishment of autumn rice can be an important risk-avoiding strategy. But the success of such a strategy is conditional on the availability of supplemental irrigation. A shift to early autumn rice (early ahu) has occurred only in areas with access to irrigation. Government policies to further expand public and private irrigation systems in Assam...
can thus help reduce the risk associated with the production of autumn rice. Therefore, if irrigation potential is created in the flood-prone area, especially during the rabi and summer seasons, farmers can use their land for cultivation of boro rice, early ahu, rabi vegetables and summer vegetables to a great extent. These strategies will enable the state to increase crop production substantially. A long term project to control flood for the farmers of the riverine area needs to be initiated.

There are several mathematical programming techniques available for modeling of specific agricultural systems problems. Probably no single model is the best at farm level, but the use of MOTAD offer a more powerful analytical instrument for agricultural systems modeling. MOTAD furnishes the farmer with very useful information on the compromise set of farm plans i.e. the risk efficient set of farm plans and trade-off among objectives. The model can be applied to a wide range of farm planning problems. It can handle agricultural resource allocation issues, satisfy multiple and conflicting objectives and environmental issues where some restrictions are required to be placed on the use of inputs with known environmental externalities. However, to do so, we need time series data on environmental variables that quite do not exist in required form.

The study identified a number of risk management strategies which have been adopted by the farmers on their own. There are still some areas which need government’s attention such as erecting dykes across the river basin, preventing soil erosion through engineering and soil conservation measures and making inputs availability to the farmers of the riverine areas at subsidized rates through agencies in time. Road connectivity to the nearby areas and markets are very essential to bring these disadvantaged areas closer to the process of development. The Char Areas Development Authority of the govt. of Assam should have a well laid out contingency plan to tackle the high risk flood situation leading to total damage of crops. The riverine areas could be promoted as production clusters for a number of cash crops including vegetables considering the fertility status of some of the areas once flood recedes.