ABSTRACTS OF Ph.D. THESES

Beohar, Bipin Bihari. 1987. Income Saving and Investment in the Context of Modern Farm Technology in Jabalpur District of Madhya Pradesh. Rani Durgavati University, Jabalpur. *Major Advisor* : S.S. Gour.

Income distribution must show sign of narrowing down with the rapid agricultural development in India. The present study examines the pattern of income, saving and investment among the farmers following traditional and modern/advanced technology of agricultural production with the following specific objectives : (1) to assess the variation and magnitude of income among selected traditional and advanced farmers; (2) to compare per capita, per household income of selected farmers; (3) to examine the consumption pattern of the selected households; (4) to evaluate the extent of savings on the selected house holds; and (5) to study the impact of modern techno'ogy on the pattern of income, saving and investment in selected households.

Jabalpur district of Madhya Pradesh was selected purposively for this study. All the four tahsils of the district were included. Four blocks were selected out of the 13 blocks of the district and again two villages were selected from the selected blocks. The farmers of selected villages were classified into 3 groups i.e. upto 2.00 ha; 2.01 to 5.0 ha and more than 5.01 ha. Sixty farmers from each group were selected. Statistical measures of central tendency, dispersion and coefficient of variation and linear and log-linear trends (growth) have been used in the analysis.

The average area under cultivable waste land in modern technology period compared to traditional showed a decline in Jabalpur district and Madhya Pradesh. Area under current fallow and other fallows was stagnant in the district and state It was observed that the average net irrigated area increased during the modern technology period over the traditional in Jabalpur district. There was positive change in average area under total pulses.

The farmers of all the three categories invested maximum for *rabi* irrigated than *rabi* and *kharif* unirrigated. On an average, the medium farmers invested more than small and large farmers. Investment increased per hectare as the size of land holding increased in both *rabi* and *kharif* season. *Rabi* investment was more than *kharif* in all the these categories.

The per hectare operating cost increased as the size of land holding increased. The cash expense incurred by small farmers under unirrigated condition in both seasons was almost same (between 31 to 34%). In unirrigated paddy and irrigated wheat, small farmers invested minimum amount of cash for labour payment while it was maximum by large farmers. As the size of land holding increases, the cash investment on human labour also increases but on bullock labour the reverse is the case. The cash investment on other items was the same on medium and small size farms.

It was observed that none of the farmers used plant protection measures. It was also observed that except unirrigated paddy and jowar, the investment on threshing and winnowing was more than on other crops and operations. Field preparation charges were more in unirrigated paddy than irrigated one whereas the sowing charges were more in irrigated paddy because of puddling. All crops had about the same sowing charges.

The maximum percentage of expenditure was incurred on threshing, winnowing and sowing the irrigated paddy whereas inter-culture operations and land preparation had the maximum share of unirrigated paddy particularly in case of large farmers. In the study area jowar crop is grown in unirrigated condition and small investment was made to raise this crop.

The investment in manuring including fertilizer and plant protection measures was zero. In all the operations except sowing the investment was more in irrigated wheat as compared to unirrigated wheat.

In the unirrigated crops, the capital required was only for seed, irrespective of the crops, except in case of paddy and gram where a small amount was required for manures by small and medium farmers. Jowar and lentil were the crops which required capital only for seed in case of medium farmers. The investment increased on the materials with the increase in the size of land holding for unirrigated crops, whereas it remained roughly the same under irrigated conditions.

The cost of chemical fertilizers increases with the increase in the size of land holding in *kharif* crops. None of the farmers made investment on insecticide/spesticides on unirrigated crops.

The cost per hectare increased with the increase in the size of land holdings irrespective of the category of the cost. Costs "A" and "B" in terms of percentage of cost "C" increased with the size of land holdings.

Gross income and the net income per farm and per hectare showed an increasing trend with the size of land holding. It was due to the modern technology used by succeeding categories but family labour and farm business income showed opposite behaviour. Per capita income from all sources was Rs. 1238, 2972 and 2584 for small, medium and large categories of farmers, respectively. A quite reasonable percentage of the total income was from service in case of medium size farmers.

As the land holding increased the total expenditure, current consumption and durable expenditure increased but durable consumption was about same in medium and large categories. The household current expenditure was lower in lower size group but increased as land holding increased. The percentage consumption expenditure on food decreased with the increase in size of farm, while that on housing, education, social ceremonies and miscellaneous, increased. The proportion of consumption expenditure on clothing remained more or less constant.

Small farmers made new investments on land and animal resources and the medium on the appliances of irrigation, implements and machinery. Small farmers improve their economic condition by new investments, although their incomes were not sufficient to meet the household expenditure.

The large farmers had sufficient income but high household expenditure and their savings were not sufficient to go in for new investments in the farming enterprise and they, therefore, had to borrow funds. The same is the case for medium farmers also.

Sarawgi, A.K. 1988. An Analysis of Growth Rate of Crops and Resource Use Efficiency of Tribal Farms in Mandla District, Madhya Pradesh. J.N. Krishi Vishwa Vidhyalaya, Jabalpur. *Major Advisor* : S.S. Gour.

The present study examines the growth rates and trends, the cost of cultivation and productivities of resources for major crops in Mandla district (a backward tribal district) of Madhya Pradesh.

Both primary and secondary data are used. The secondary data relate to the period 1956-57 to 1981-82. The time period has been split into (a) short-run period analysis (i) traditional technology, i.e. 1956-57 to 1966-67 (ii) modern technology period i.e., 1967-68 to 1981-82 (b) long run period analysis, i.e. 1956-57 to 1981-82. The primary data on input output for the major crops were collected from 120 sample farms, 40 in each category of small, medium and large size of land hold-

ings of 8 selected villages by survey method. The primary data relate to *kharif* and *rabi* seasons of the year 1985-86.

Trend analysis showed that rice and wheat gained significantly with respect to area, total production and productivity during the modern technology period in Mandla district. Rice crop of Mandla district performed better than M.P. during the modern technology period. The trend coefficient analysis of wheat suggested a cropping pattern change in Mandla district and are in line with the results for M.P. In case of kodo-kutki during modern technology period, there was significant reduction in area and production and the levels of productivities were negative but insignificant in all the three periods. Gram area had negative trend but productivity had a positive trend leading to a conclusion that better gram production practices were adopted by the farmers of Mandla district. Gram crop did better in Mandla district as compared to M.P. Linseed crop area as well as productivity showed significant increase in all the periods. Such a behaviour of linseed is the result of improvement in crop production technology in Mandla district. Linseed crop performed better in Mandla district than Madhya Pradesh.

The average size of holding of sample farmers was 4.156 hectares with very small percentage of area under irrigation. In view of the per cent level of irrigation, the farmers had quite a high level of intensity of cropping.

The cost of cultivation (C_2) per hectare among the different sizes of land holdings were roughly the same except in small over the medium size in unirrigated paddy. Irrigated paddy production required 17% more expenses than unirrigated paddy. The total cost of cultivation per hectare of small size group was significantly higher than the large size group for kodo-kutki. The total cost of cultivation per hectare among sizes of land holdings under irrigated and unirrigated wheat were roughly the same. The total cost of cultivation per hectare of unirrigated gram on small holdings was more than that on medium holdings and that on large holdings was more than on medium holdings. The total cost of cultivation per hectare of linseed was significantly higher in medium size over the large size of land holdings.

The levels of production were significantly higher under irrigated as compared to unirrigated conditions for selected crops included in the study. The levels of unirrigated paddy and gram production on small farms were found to be significantly higher than on the medium and large farms. In kodo-kutki, production on large farms was significantly higher than on small and medium farms. Levels of irrigated wheat production of

medium and large sizes were significantly higher than of small farms. Levels of unirrigated wheat production do not differ significantly among different sizes of land holdings. There was no difference in the levels of linseed production among different sizes of land holdings.

The production function analysis revealed significant coefficients for unirrigated paddy crop of human labour in all the three sizes of land holdings and bullock labour on small and large sizes. This indicates that these, if increased, will increase the production of paddy crop under unirrigated condition. In kodo-kutki, production will increase by increasing land and human labour. Land had positive and human labour negative relationships with the size of land holdings. The coefficients for land and human labour were significant in the three size groups for unirrigated wheat. Only seed, if increased, on small and large sizes of land holdings will increase the production of irrigated wheat. For unirrigated gram, bullock labour in all the three sizes of land holdings, land on medium and large sizes and seed on small and medium sizes will, if increased, lead to increased production. The coefficients indicate the possibility of increasing human and bullock labour and seed inputs in the production of irrigated gram. Increases in land in all the three categories and human and bullock labour on small and large sizes, will increase production of linseed crop.

The estimated marginal value productivities reveal that an increase of a unit of investment on human labour in all the three size groups, bullock labour on small and large size groups will add Rs. 1.26, Rs. 5.19, Rs. 1.58, Rs. 3.52 and Rs. 2.68 to the gross income of unirrigated paddy, respectively. The marginal value productivities of land of kodo-kutki were Rs. 228.02, Rs. 272.14 and Rs. 313.12 for small, medium and large sizes of land holdings, respectively. Thus, there is further scope for extension of area under the crop. Increase in the investment on human labour on small size of land holdings only will add to gross income. In unirrigated wheat, increases in land and human labour inputs will increase profits. In case of irrigated wheat, increase in seed will add to the profits of the farmers. In unirrigated gram, increase in bullock labour and seed inputs will add profits on small farms, whereas extension of land area on medium and large farms will increase profits. Increase in human and bullock labour and seed will increase profits on irrigated gram. In case of linseed, increases in area and human and bullock labour use on the three categories will increase profit except in case of human and bullock labour input on medium farms.

Constant returns to scale were observed for all the five crops on all categories.

Krishan Kanta. 1990. Dynamics of Agricultural Transformation in Himachal Pradesh. Himachal Pradesh University, Shimla. *Major Advisor* : R. Sharma.

The present study is an attempt to provide a consolidated picture of agricultural change in the rural economy of Himachal Pradesh since 1951. The study is based on secondary data. An attempt has also been made to carry out the analysis at a regionally disaggregated level, to the extent possible.

The study focused on questions such as : How has Himachal Pradesh's farm sector performed over time ? How has the sector responded to changing economic conditions as well as policy stimuli in the last four decades ? What are the positive and the negative characteristics of the sector from the angle of its dynamic growth, and so on.

The hypothesis of dynamics of agricultural transformation in Himachal Pradesh has been tested with the help of following indices; relative rate of growth of total and sectoral incomes, institutional changes, particularly the size distribution of ownership and operational holdings as well as the extent of tenancy, technological changes, changes in cropping pattern and behaviour of production and productivity of major crops over time. The different dimensions of changes in the agricultural sector in the state have been discussed vis-a-vis similar changes in the Indian economy as a whole wherever comparable data were available.

Compound growth rates were estimated to evaluate the growth of net state domestic product by fitting log-linear curve. The inequality in the distribution of land and associated assets was estimated with the help of Gini's ratio. Since Gini's ratio is a summary statistic incapable of providing information about the nature of change that occurs over the period, the comparison of the relative position of the size group in the two periods have been carried out with the help of an index of inter-class concentration. In order to test for the significance of changes in the two distributions a weighted Chi-square value is used. Chi-square test has been applied to examine the changes in cropping pattern.

Pattern of growth in area, production and productivity from 1952-53 to 1986-87 has been split in two periods -I : 1952-53 to 1964-65, and II : 1965-66 to 1986-87. Period II has further been divided into two sub-periods of 1965-66 to 1975-76 and 1976-77 to 1986-87 to clearly bring out the trend in more recent period. The growth rates have been computed by fitting a log-linear curve to the index of time series data in each case.

The relative contribution of different elements to the growth of crop output in the case of ten major crops in terms of physical components at two different points of time was carried out by following a modified procedure of Minhas-Vaidyanathan model.

The results indicated that net State domestic product of Himachal Pradesh increased at 3.78 per cent per annum between 1950-51 and 1965-66 and at the rate of 2.38 per cent per annum during 1966-67 and 1984-85. The period 1970-71 to 1984-85 was, however, marked by sharp fluctuations. Moreover, the growth rate of income from the primary sector, which was negative 0.23 per cent per annum has lagged behind the growth rate of 2.11 per cent per annum in total State income leading to the change in the composition of State income mentioned above. The growth in agricultural income has thus lagged behind the growth of rural population with the result that per capita agricultural income has virtually started declining, though total per capita income in the State has increased slowly at a rate of 1.50 per cent per annum.

The rural economy of Himachal Pradesh like that of the country is highly inequalitarian with bulk of assets concentrated in the hand of a small number of households. There is no indication of any sharp change in the composition of the total rural assets during the period. The share of non-cultivator households vis-a-vis that of cultivator households in the total rural assets has gone up. The distribution of land and durable household assets is comparatively more inequitous whereas the distribution of vacant house-site and financial assets is much less unequal. The relative improvement in the asset distribution among cultivator households was made plausible largely by a reduction in the inequality in land holding distribution, with the large farms losing in favour of small and medium farm classes. Land owned/operated has emerged as an important factor having its influence over the command of non land assets.

The cropping pattern has remained dominated by foodgrain crops which cover more than 85 per cent of the cropped area. The changes in cropping pattern shows overall stability in the cropping pattern. But the spatially disaggregated analysis clearly shows that significant changes have occurred in some districts. An inverse relationship between the proportion of area under wheat and rice and size of farm, and a reverse relation in the case of area under non-food crops and farm size emerge from this analysis.

One thing that stands out in the growth performonce of the agricultural sector of Himachal Pradesh since independence is that the growth

rate of foodgrains production which was as high as 3.63 per cent, the growth of area 0.62 per cent and growth of productivity 3.00 per cent per annum during 1952-53 to 1964-65 has failed to get accelerated during 1965-66 to 1986-87 period.

Time series analysis of acreage, output and yield data for major crops of Himachal Pradesh for period I (1952-53 to 1964-65), and period II (1965-66 to 1986-87) revealed that except in the case of wheat, the impact of new technology in terms of productivity growth has been negligible. A further disaggregation of period II into sub-period I (1965-66 to 1975-76) and sub period II (1976-77 to 1986-87) clearly shows that the latter sub-period was marked by a poorer performance of major crops in terms of growth of production and productivity.

A comparison on the basis of the component analysis for the period I and period II shows that there has been decline in the role of real factors in determining the rate of growth of farm output, whereas the significance of monetary factors has increased in the latter compared to the former period.

The overall conclusion that emerges from the study is that though the state did show some signs of change, yet these can hardly be termed as 'transformation'. 'Transformation' means sweeping structural changes which normally accompany growth and help keep growth rates from falling.

Thakur, C.L. 1990. Study on the Patterns of Energy Consumption in Agricultural Sector of Madhya Pradesh. Rani Durgavati Vishwa Vidyalaya, Jabalpur. *Major Advisor* : B.L. Mishra.

The present study on the pattern of energy consumption in agricultural sector of Madhya Pradesh deals with energy as a key input for agricultural production and economic growth.

The state of Madhya Pradesh is delineated into five crop zones viz., (i) Rice zone (ii) Rice-Wheat zone (iii) Wheat zone (iv) Jowar-Wheat zone and (v) Cotton-Jowar zone. The study covered the entire state representing different crop zones and agro-climatic regions. The sample included 100 households from each crop zone covering 12 villages in 12 districts in each agro-climatic region of M.P. The crops included in the study were paddy, soybean, jowar, arhar, cotton, maize, wheat, gram, mustard and sugarcane. Primary data on operationwise and sourcewise energy and cost consumption of crops were collected from each crop zone for marginal (less than 1.00 ha), small (1.00 to less than 2.00 ha), medium

(2.00 to less than 4.00 ha) and large farmers (4.00 ha and above) as per specified sampling design. The energy use in terms of sources and operations expressed in hours was converted to MJ/ha. (10^6J = 1 MJ). The energy units were further transformed in to their money values to estimate the cost in relation to energy consumed. After tabular analysis, the associations of crop yields and energy inputs both in physical and monetory terms were also determined through correlation coefficients between energy use and cost, energy use and yield, energy use and net profit, energy use and human labour and energy use and bullock labour. The advanced and traditional technologies of crop production were considered separately to find out the energy and yield gaps per hectare.

Operationwise energy consumption was lower than sourcewise energy use of crops in all crop zones as the energy of material inputs was included in the total energy consumption. Seedbed preparation consumed most of energy in most of crops included in the study. Irrigation was another important operation in terms of energy consumption specially in case of sugarcane and wheat. Operationwise energy consumption was in general higher on marginal farms mainly because of the excess use of manual labour in crop production. On tractor operated large farms energy consumption exceeded in all crops in all crop zones and revealed better yield performance in comparison to other categories of farms. Fertilizers use level for all the crops in all the crop zones was less than the recommended dose.

Considering the total energy consumption according to samples, the specific energy consumption ranged from 4.06 MJ/kg to 4.15 MJ/kg in rice-zone in case of paddy. It ranged from 4.20 MJ/kg to 5.37 MJ/kg in case of wheat, from 6.58 MJ/kg, to 6.80 MJ/kg in case of soybean. Cultivation of wheat proved to be least energy efficient (5.37 MJ/kg) in jowar-wheat zone while it most efficient (4.20 MJ/kg) in rice-wheat zone. Gram was found to be heavy consumer of energy per unit of output (4.25 MJ/kg) in wheat zone and it was most efficient energy user (3.48 MJ/kg) in jowar-wheat zone. Sugarcane was found to be more efficient in terms of energy consumption (0.76 MJ/kg) in cotton-jowar zone against (0.83 MJ/kg) in wheat zone. Energy consumption per kg of jowar output was lowest (3.63 MJ/kg) in jowar-wheat zone while it was highest (5.29 MJ/kg) in wheat zone.

In terms of monetary value of the energy consumption of crops per kg of output, it was lowest (Rs. 2.24/kg) in case of sugarcane and highest (Rs. 7.65/kg) in case of cotton in cotton-jowar zone. In rice-wheat zone-cost of production per kg of output was highest (Rs. 3.39/kg) for soybean

followed by Rs. 1.82/kg for gram, Rs. 1.56/kg for paddy and Rs. 1.18/kg for wheat. Similarly the highest cost of production Rs. 4.32/kg was in case of soybean and lowest (Rs. 0.27/kg) for sugarcane in wheat zone. Highest cost of production (Rs. 5.52/kg) was estimated for mustard in jowar-wheat zone while it was lowest (Rs. 1.54/kg) for wheat.

The ratio of return per rupee invested in production of crops (benefit cost ratio) was estimated to be highest (3.18) for gram among all crops and all crop zones of M.P. It was lowest (0.52) for maize in cotton-jowar zone.

The total energy gap for the crops at the state level added upto 99806 TJ (10^{12}J = 1 TJ) of energy valued at Rs. 2798 crores. The highest gap between recommended and actual energy consumption was estimated for paddy followed by wheat. The monetary value of annual production loss at prevailing prices is to the tune of Rs. 5194 crores indicating the highest loss in rupees of paddy followed by wheat. The annual production losses in case of mustard, soybean, gram and arhar add up to Rs. 1419 crores.

Significant positive correlations were generally found between energy use and cost, energy use and yield and energy use and net profit. The correlation between total energy use and human labour and total energy use and bullock labour were generally found insignificant in all crops and all crop zones of the state.

Patel, G.N. 1991. Price Behaviour and Marketing of Groundnut in Gujarat, Rajasthan Agricultural University, Bikaner. *Major Advisor* : N.L. Agrawal.

The present investigation was carried out to study the growth rates and instability in groundnut production, inter-and intra-year movement in prices of groundnut pods and its oil, price integration, returns to storage and transportation, marketing pattern and costs, margins and price spread in marketing of groundnut in the selected markets of Gujarat state. The study was centered in five major groundnut producing districts (Amreli, Bhavnagar, Jamnagar, Junagadh and Rajkot) of Saurashtra region of Gujarat which account for more than 80 per cent of area and production of groundnut in the state.

Production of groundnut declined in the state by 3.42 per cent per annum in 1960-61 to 1969-70 period and by 1.78 per cent per annum in 1970-71 to 1988-89 period. Among the districts, production declined in Rajkot district by 3.44 and 8.29 per cent per annum in Period I and II,

respectively. In other districts, production has shown negative but non-significant growth in both the periods. Area under the crop in the state as well as in Amreli and Bhavnagar districts decreased significantly by 2.23, 0.85 and 4.46 per cent per annum, respectively during 1960-61 to 1969-70. Only Junagadh district recorded positive significant growth of 1.04 per cent in area under the crop in this period. Though productivity growth rates of the crop were negative in some districts and positive in others but all these were non-significant in both the periods. Only Rajkot district experienced significant negative growth of —7.96 per cent in productivity of the crop in the second period. The magnitude of instability increased overtime for all the three variables. i.e., from 55 to 209 per cent for area, 59 to 165 per cent for production and 45 to 152 per cent for productivity in the districts and state as a whole. Yield variance was the dominant source accounting for more than 80 per cent of the total variance in groundnut production.

Wholesale as well as farm-harvest prices of groundnut pods and its oil increased overtime. The gross increase was 158 to 227 per cent in farm-harvest prices of pods, 173 to 297 per cent in wholesale prices of pods and 254 to 262 per cent in groundnut oil during the last 14 years period (1975-78 to 1987-89). Prices of pods increased by 9 to 11 per cent per annum, whereas wholesale prices of groundnut oil increased by 12 per cent per annum. Among the markets, the rate of increase in prices was higher in Una market for wholesale prices of groundnut and in Amreli and Rajkot districts for farm-harvest prices of the crop. There was no variation in the rate of increase in wholesale prices of groundnut oil in the selected markets.

Prices of groundnut pods and its oil show seasonality with price indices reaching the lowest level in harvest season months (October-December) and the highest level in sowing season months (July-August) in the selected markets, except the Mahuva market. Month by month analysis of returns to storage revealed that storage of groundnut was a paying preposition when stored groundnut pods were sold in July and August months. Thus, profit from storage exists only when timing of sale is judiciously decided.

Markets situated at a greater distance displayed high price difference compared to market pairs located nearer to each other. High estimate of correlation coefficient for monthly wholesale prices of groundnut pods between primary and corresponding secondary wholesale market pairs as well as between secondary wholesale market pairs revealed that the markets were well integrated in respect of price movement in them. The

returns to transportation was sufficient (Rs. 9 to Rs. 45 per quintal) only in Mahuva-Amreli, Mahuva-Gondal and Rajula-Amreli market pairs to warrant the cost necessary for movement of groundnut from primary to secondary markets. In other primary-secondary market pairs (Kalavad-Gondal, Kalavad-Rajkot, S. Kundala-Amreli, S. Kundala-Gondal, Una-Gondal and Una-Rajkot market pairs) and between the secondary wholesale market pairs (Amreli-Gondal, Amreli-Rajkot and Gondal-Rajkot) positive returns to transportation were not there. The results of Koyck model also revealed that in both types of market pairs, prices were significantly influenced by their lagged month's prices as well by the prices of their corresponding paired markets.

The marketable and marketed surplus of groundnut was more than 75 per cent in Zone I villages (located at 10 kms distance from Gondal mandi) and in Zone II village (located at more than 25 Kms distance from Gondal mandi). Farmers marketed 80 per cent surplus in the regulated markets and only 20 per cent in villages. Small farmers disposed off more than 75 per cent surplus in the first quarter after harvest (October to December) and that too in a single lot. Medium and large sized farmers disposed off the surplus groundnut in various quarters of the year in 2 to 4 lots.

Total marketing cost in sale process ranged between Rs. 61 to Rs. 76 per quintal of groundnut or 8 to 10 per cent of the processor's sale price in different channels. The oil miller got a margin of 9 to 19 per cent, wholesaler 4 to 6 per cent and village merchant 4.55 per cent of the processor's sale price in the identified channels. No definite relationship could be established between length of channel and producer's share. Producer's share in the terminal price in the identified three channels ranged between 71 to 77 per cent.

Padmanaban, N.R. 1992. Study on Water Use Efficiency and Management in Krishnagiri Reservoir Project—A Simulation Approach. Tamil Nadu Agricultural University, Coimbatore. *Major Advisor* : C. Ramasamy.

The present study was undertaken during 1990-91 to study the system management and existing pattern of distribution of water and the water use efficiency and to develop a simulation model for conjunctive use of surface and ground water. Primary data were collected from 120 sample respondents in head, middle and tail regions of both left and right main canals. Secondary data were collected from the dam authorities and used in the simulation model.

The study revealed that the farmers applied more of K and less than the recommended level of N and P to Navarai paddy (Nov-April) and the average yield was 3836 kg/ha. The study also revealed that as irrigation distance increased the productivity of paddy decreased. The cost of cultivation of Navarai paddy ranged from Rs. 5410.84 to Rs. 7096.81 per ha. The average water use in the head region was 160.13 ha cm, 158.99 ha cm in middle region and 115.05 ha cm in tail end areas. The study brought to light that there was considerable variation in water use within the same region.

The water use efficiency was highest in tail region with 32.85 kg/ha cm of water, followed by middle region 26.88 kg/ha cm and head region with 22.50 kg/ha cm.

The estimated translog production function for head, middle and tail regions revealed that the coefficient of multiple determination was 0.90, 0.87 and 0.89, respectively, indicating the specifications and selection of functional form were appropriate. From these results marginal physical product, marginal value product, elasticity of production and elasticity of substitution were estimated. The elasticities of production of NPK nutrients and water were significant whereas labour was not significant in all the three regions. The MPP for water is negative in head region indicating that the water is overused. The estimated elasticities of substitution of NPK with water were —0.152 in head region, —0.170 in middle region and —0.140 in tail region respectiveiy, implying that these two inputs are substitutes.

The water balance of KRP system at existing level showed that the total water availability at field level was 898.180 mcuft as against the requirement of 1644.933 mcuft, leaving a deficit of 746.753 mcuft. The supplementation potential from well was assessed at 592 mcuft. The water balance at optimum water requirement level showed that the deficit reduced to 488.773 mcuft.

The simulations of KRP with lining of main canal and distributories will lead to a situation where the deficit will be reduced to 522.208 and 372.511 mcuft at existing water use level and 264.228 and 114.531 mcuft at optimum water use level. The change in crop patttern (450 ha) may result in reduction of deficit to 603.747 mcuft at existing level and 369.602 mcuft at optimum level.

The simulation analysis revealed that the water deficit could be reduced significantly through lining of canals, distributories and changed crop pattern. The productivity could be increased substantially if the

water is used at optimal level along with other crucial inputs like fertilizer and labour.

Hazarika, Dinesh. 1991. Farming System Analysis Under Flood Prone Situations in Assam : A Study of Lakhimpur and Nagoan Districts. Assam Agricultural University, Jorhat. *Major Advisor* : B.C. Bhowmick.

The study was undertaken in the North Bank Plain and Central Brahmaputra Valley Zones of Assam in the year 1989-90. A two stage stratified random sampling technique was adopted for selection of ultimate sample. The relevant information were collected from three situations viz; chronically flood affected, occasionally flood affected and flood free situations from small, medium and large size groups of farms. All together 152 respondents were considered for the study. The main objective of the study was to examine the existing pattern of resource use in various size groups of farms under the three situations on their existing farming systems and to develop appropriate optimal plans to suggest alternative farming system by using deterministic linear programming as well as maximum admissible loss programming (at different probability levels) for minimizing loss. The possibilities of trade-off of loss-return were also explored for minimizing loss (risk) through alternative (less risky) activities.

Coefficient of variation (CV) and mean deviation (M.D.) of major crops in the study area were determined to establish the magnitude of variability in yield of crops. Crops like potato, summer rice and wheat were found to be more risky as indicated by high C.V. value. The yield of other crops such as rape and mustard, jute, autumn rice, winter rice, linseed, etc. were found to be less risky enterprises.

Optimal plans were developed using existing resources and existing resources with labour hiring, capital borrowing and other purchasing activities. The plans revealed that remunerative crop enterprises like summer and winter rice (H), potato, arecanut appeared with larger areas or numbers as the case may be and less remunerative enterprises either appeared with small areas or were eliminated from the plans altogether. Area under rice was found to be dominant in all the size groups of farms under all the situations. Among the rice, area under summer rice increased in most of the optimal plans. Area under kitchen garden was utilized fully in summer and *rabi* seasons. Among animal activities, pig and goat appeared to be remunerative as both these activities appeared in most of the optimal plans.

The set of optimal plans were developed through maximum admissible loss programming (MALP) for different levels of minimum income. The value of minimum income was parameterised to obtain different change of basis solutions till the solution remained feasible. There is an inverse relationship between minimum income and loss value. The risky enterprises like summer rice, potato, etc. either have appeared with smaller area or were eliminated in the successive MALP plans in most of the size groups of farms at all the three levels (0.15, 0.30 and 0.45) of probability considered.

To get stable income from the farming business, area under risky crops like summer rice could be substituted to other less risky crops like rape and mustard, wheat or linseed in *rabi* season and jute or autumn rice in summer season subject to the availability of limited resources. This could help in stabilizing farm income in most of the size groups of farms under all the situations.