OPTIMUM CROP AND LIVESTOCK PRODUCTION DECISIONS UNDER UNCERTAINTY IN BANGALORE DISTRICT-KARNATAKA

A THESIS
SUBMITTED TO THE KURUKSHETRA UNIVERSITY
FOR THE AWARD OF THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN THE FACULTY OF
DAIRYING, ANIMAL HUSBANDRY AND AGRICULTURE

BY
S. VIJAYALAKSHMI

DIVISION OF DAIRY ECONOMICS, STATISTICS AND MANAGEMENT
NATIONAL DAIRY RESEARCH INSTITUTE
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Registration No. 82-UD-Ph. D. 8

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With the Blessings of

MY MOTHER

I DEDICATE THIS HUMBLE WORK TO THE MEMORY OF

MY LOVING FATHER

AND ALSO TO

Late Dr. D. SUNDARESEN

FORMER DIRECTOR OF

NATIONAL DAIRY RESEARCH INSTITUTE, KARNAL

FOR HIS UNSTINTING ENTHUSIASM AND ENCOURAGEMENT

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Dated, the 24th September, 1985

I certify that the work reported in this thesis entitled, "Optimum Crop and Livestock Production Decisions under Uncertainty in Bangalore District - Karnataka" was carried out by Miss S. Vijayalakshmi under my guidance, for the requirement of the Degree of DOCTOR OF PHILOSOPHY in the Faculty of Dairying, Animal Husbandry and Agriculture of the Kurukshetra University, Kurukshetra.

(R.K. PATEL) 24/9/85

A C K N O W L E D G E M E N T S

"To be or not to be" grateful is not the question, how to be, is the one: Words fail me to express the feelings I hold for my guide, Dr. R.K. Patel, Ph.D. (Ohio), Senior Professor, Division of Dairy Economics, Statistics and Management, National Dairy Research Institute, Karnal, who laid the foundation upon which the frame-work of my thesis stands and also who made me worth of what I claim to be now.

No amount of vocalization of thoughts is sufficient for conveying my gratefulness to Dr. R.Nagarcenkar, Director, National Dairy Research Institute, Karnal for providing me the necessary research facilities and also for providing me moral support during crucial periods.

Grateful thanks are also extended to Director, Indian Council of Social Science Research for allowing me to avail short term fellowship.

Constant encouragement and support I received throughout the study period were because of Dr. B.S.Rawat, Head, Division of Dairy Economics, Statistics and Management, N.D.R.I., Karnal for which I am highly indebted.

"Gratitute is one of the least articulate of the emotions, especially when it is deep". Such is the feeling I hold for Dr. S.R.Sampath, Head, Southern Regional Station of National Dairy Research Institute, Bangalore, whose wisdom, counsel, guidance and assistance made me to carry out the task patiently and diligently.

Innumerable appreciations are reserved in the core of my heart for Senior Professionalist and Scientists of the Division of Dairy Economics, Shri S.C.Dass, Dr. C.B.Singh, Dr. Rajvir Singh and Dr. V.K.Kesavan for their critical evaluation of the research findings of this present work. In fact, it is hard for me to express sufficiently my heartfelt thanks for the help I received from them.

I am grateful to the Team headed by Dr. K.N.S.Sharma, who planned and organized the project "Economics of crossbred cattle in Bangalore", to the investigators who collected the data from the sample farm households and to the selected farmers who co-operated with the investigators in providing needed information.

This work would not have been possible but for the sacrifice and pains taken by my brother, Bhasker, a research fellow of Indian Institute of Science, Bangalore, who successfully brought out the computer results.

The quick and efficient service of Shri Roshan Lal Gupta in bringing out the thesis in typed form is also acknowledged gratefully.

I am also thankful to all my friends, well wishers and collegues whose encouragement gave me strength during depressed situations.

Last but not the least the understanding, adjustments and prayers of my brothers and sisters made me balanced throughout the course of this study, for which I am highly obliged.

Srijayalakshmi

(S. VIJAYALAKSHMI)

C O N T E N T S

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CHAPTER – 1

INTRODUCTION

INTRODUCTION

1.1 SPECIFICATION OF THE PROBLEM

Agriculture in India is a gamble with monsoon. Net returns from farms are effected not only by a wide variety of external factors such as physical, economic, climatic, agronomic, biological, size and scale of enterprise etcetra but also by the inherent features of agricultural production process itself. Major features of this process are, i) time-lag between inputs and output, ii) past price-tag attached to present production decision, iii) expectation based farm planning horizon, and iv) unforeseen events and untimely technical help which slacken the production efforts. The yield and price instabilities in agricultural commodities continues to plague consumers as well as producers. Farm costs have to suffer inflation.

Farm plans in India are characterised by mixed farming, a combination of more than one enterprise for obtaining farm income. Farm plans, whether to alter or adjust, or to supplement or supplant are frequently revised because of the intruding stochastic elements in farm production.1/ Very often farmer's decisions with imperfect knowledge surpass his expectations, leaving him in sub-

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1/ Heady, E.O., and Dillon (1961) "Agricultural Production function" Iowa University Press, Ames, Iowa; p.634

optimal, infeasible farm plan level. The more this dispersion of expectation, the greater is the degree of uncertainty in the farm economy.2/ An efficient farmer is one who not only should know how to manage his limited resources among competing farm activities but also how best to steer clear of the probable risk and stabilize production.

It is generally felt that small farmers, by virtue of their subsistence level, are risk averters.3/ As a defence against subsistence risk4/ mixed or diversified farming activities such as milk production, sheep keeping, silk worm rearing are undertaken.5/ In the guise of subsidiary occupation, dairying and sericulture compete with crops for land, capital and labour because they are not easily insulated from the rest of the farm enterprises.

The complexity of the dairy enterprise calls for considerable managerial ability on the part of the farmer. Instability in the yield of field crops, especially those cultivated on rainfed land, influences the dairy and allied activities by its uncertain supply of both the main and the byproducts. Along with variability

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2/ Martin Upton (1976), 'Agricultural Production Economics and Resource Use'. Oxford University Press. pp. 191-192

3/ Dillion, L. John and Pasqualle, L.Scandizzo (1978) Risk attitudes of subsistence farmers in North East Brazil- A sampling approach' Amer.J.Agri.Econ. (60) 3, 425-435

4/ Behrman, J.R. (1968) Supply response in under developed agriculture, Amsterdam, North Holland, Publishing Co. USA.

5/ Rajagopalan, V. and S.Varadarajan (1978) Impact of Risk and Uncertainty on Farm Production and Income on Hill of Nilgiri, Tamil Nadu, Indian J.Agri.Econ. 33 (4).

in production, the perishability of the products calls for a permanently feasible plan that would alleviate the effect of frequent fluctuations in the returns - irrespective of the type of farming.

India has been labouring under great pressure of population. One of the manifestation of this pressure is inherent in the continuing sub-division and fragmentation of land holdings which has reduced the farm to uneconomic levels with conventional inputs and traditional techniques. This increasing atomization of Indian agriculture with corresponding decrease in the unit of management of land aggravate the condition of farming community, which already has vagaries of monsoon to encounter.

Milk as a food stands as a perfect complement to cereal based diet 6/ and milk production as an enterprise with high yielding animals and improved technology yields higher net returns to the farmers. 7/

In view of the many benefits accrued from bovine keeping there has of late been an unflinching support from government and ceaseless efforts from research institutions to reinvigorate animal production.

6/ Hodgeson, J.Harlous (1979) 'Dairy cow in World Food Production, J.of Dairy Science. 62 (2) 343.

7/ Patel, R.K., P.Kumar, D.Voegele, R.S.Nair and G.S. Nair (1975) Economics of crossbred cattle - A Report of Survey, N.D.R.I., Karnal.

The present livestock population, especially milch bovine[8/] lies scattered among millions of small farms, involving large number of operators who do not normally follow the norms of input-output efficiency. As a result, the productivity of both draft and dairy animals are abysmally low.[9/] During the last three decades much has been done in promoting the development of dairy cattle and buffaloes in the country. The results of performance of the different categories of crossbred cows conclusively indicate that the crossbreds are well adapted to the agro-climatic conditions prevailing in the country and are capable of yielding considerable quantities of milk compared to the zebu cattle.

Improved breed calls for improving the feed availability situation in the country. In other countries where the productivity of dairy cattle is very high, 62 per cent of total feed units of milch cows are obtained from feed grains and forages.[10/] But, in India, limited access to land due to its very unequal distribution

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8/ Of the 230 million cattle and buffalo only 81 million (35 percent of total) are milch animal - Source Bhattacharya, P. (1976) New strategy in Animal Husbandry. Indian Dairymen 28 (2) pp. 48.

9/ It is generally quoted that average milk production desi cow is around 157 kg per year and that of buffalo 504 kg per year. Source: 'Times of India - Year book and Directory (1983).

10/ Sampath, S.R. (1981) Development of fodder resources for increased milk production - Paper presented at the seminar on Increased Milk Production for Urban Market conducted by University of Agricultural Sciences, Hebbal. Dec. 27-29.

and the pressure of population constitutes a major constraint on feeding practices. Hence feeding grain to ruminant with moderate productivity amounts to a luxury consumption of valuable resources.

Out of 306 million hectares which are available for agricultural purposes in the country, only 4.38 per cent is allotted for forage production, which in due course is likely to get reduced.11/ The permanent pasture and grazing lands which come to 13 million hectares, are yet to be technically planned for growing legumes and grasses. Considering the importance of livestock under new breeding programme, the present position of forage availability vis-a-vis its requirement and the competition of food and fodder crops on cultivated land, new production systems need to be tailored.

Over two decades, poineering efforts in introducing innovations in rural economy have been made to lift the farming community from subsistence level to a self sustained plane. There has been an ever increasing research emphasis to aid the planners, policy makers and financiers in formulating and executing decisions at macro level but they have yet to succeed in changing the risk averting farmer to come in line with the new technology.

11/ Patil, B.D. and Masood Ali (1983) 'Increasing forage and food production in rainfed areas' Indian Farming, Vol. 32, No.10, pp.17.

The complexity of rural subsistence level precludes a simple or universal solution. The recent gains in crop production in India, it is felt, have not commensurated with similar trends in animal production. 12/ Increased milk production by following improved breeding policy has still to make its mark felt. Development in the dairy field still lags behind crop production. Very often the following crucial questions are raised at the intellectual level. i) What are the problems faced by farmers in stabilizing farm income? What could be the probable ways to stabilize returns from farm produce? What would be the predicted level the farm could reach at its optimum use of available resources? ii) What is the role that dairying with crossbred cows can play in the farm economy? To what extent it is complementary or competitive or supplementary? What type of animal and what are the optimum number of animal a farm can have? 13/ At what level of milk production, fodder cultivation becomes remunerative? Milk production - at what price level becomes an economic stimuli and upto what level it becomes an economic constraint? iii) What are the prospective uses of limited resources?

12/ Patel et al. opp.cit.

13/ Patel, R.K. (1981) 'Economics of Livestock Enterprise with special reference to its employment potential'. Indian J.of Agri.Econ., Vol.36, No.1, pp. 34-37

iv) The extent of restraint felt by farmers in taking risk in crop-dairy enterprise combination. v) Nature of risk in keeping crossbred cow for enhanced farm income.

These are some of the oft-raised questions which engage the attention of research workers. Studies undertaken earlier, were largely appropriate to static farm situations where yield per hectare or per animal and prices of their produce do not undergo any variation. Such conditions are only utopian concepts.

A descriptive study undertaken to assess the impact of dairy development in rural areas of Karnataka indicated that the process of dairy development in the state has bestowed certain benefits on large and affluent milk producers as against the weaker sections.14/ Where cross-breeding work is supposed to have been successfully implemented there is, however, no sign of any change in the cropping pattern of the region.15/ To have a deeper probe into the problem the present study was undertaken in rural areas of Bangalore District of Karnataka for reasons of the existence of densely populated pocket of crossbred cows generating income

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14/ Nyholm, Klaus (1974) 'Socio-economic aspects of dairy development - Report from Bangalore Milk shed area'- Economic and Political weekly, Vol. IX, No.52, Dec. 28

15/ Rajpurohit, A.R. (1978) 'Evaluation of cross breeding programme for cattle in India'. Agricultural Development and Rural Transformation unit, Institute for Social and Economic Change, Bangalore. page 37.

for the farming community. This area of study is suitable for an appraisal of production decision with crossbred cow - an improved technology in dairying which was introduced two decades ago. Guided by the economic, technological and subsistence criteria, combination of livestock enterprise in the farm enterprise-mix are attempted to bring stable maximum profit.

The objectives of the study are as follows:

i) To develop alternative farm production decisions with existing and improved level of technology for crop and livestock production,

ii) to ascertain the nature and degree of instability in farm business in the study area,

iii) to explore the possibilities of deriving higher farm income by studying risk efficient production decisions for each production policy alternative using improved level of farm technology.

1.2 ORGANIZATION OF THE STUDY

This study has been presented in nine chapters starting with introduction and scope of the problem of efficient farm plan in Chapter 1. This is followed by review of existing literature in areas relevant to the objective of the study namely, risk neutral farm plans, nature and extent of instability in farm business and risk efficient farm plans in Chapter 2. Chapter 3 deals with the general background of the study area and in

Chapter 4, the sampling design, models used along with various resource constraints of the farm are discussed. The results obtained through tabular analysis are presented as current status of farming in Chapter 5.

Chapter 6, by assuming risk neutral farm situations works out the optimum plans for each type of farming system, namely, marginal, small, medium, and large under two types of technological conditions, existing and improved. In this chapter, in addition to the optimum farm plans, auxiliary information such as opportunity cost of non-plan activities, prices at which food grain and milk could enter market have been attempted In short, under risk neutral farm plans, additional information such as shadow prices of constrained resources or restriction and opportunity cost of non-plan activities are provided. Such information could answer some of the questions raised earlier and which are not brought out by earlier studies.

Chapter 7 explores the nature and extent of fluctuations in farm net returns and the interrelationship between various enterprises in increasing or decreasing variability.

Chapter 8, by including the fluctuating gross margin as one of the constraint brings risk efficient farm plans for all categories of farm situations.

The findings of the study and the conclusion drawn therein are finally summarised in Chapter 9.

CHAPTER - 2

REVIEW OF LITERATURE

REVIEW OF LITERATURE

A considerable amount of work has been done in India on land and water management, and crop and livestock improvement under varied agro-climatic situations over two decades or so. The pioneering efforts in blending crop and livestock technology ultimately aim at lifting the subsistence farming community to a self sustained plane. The central problem in combination of farm enterprises is the allocation of farm resources to each enterprise in such a way that maximum net returns for the farm as a whole could be obtained. This problem of resource allocation was attempted by earlier studies by using conventional programming models having a variety of constraints. Yet, optimum farm production plans for farmers remain obscure due to uncertain and unstable farm production and farm returns. Various statistical tools were used by many descriptive studies to measure the instability in farm productivity, prices and net income. However only a few studies took into account the fluctuating gross margin of farm in designing optimum farm plans.

In order to have deeper insight and identification of gaps in knowledge and for indicating the directions for future lines of research, it becomes imperative to review the existing literature on the subject. In this chapter, therefore, the empirical studies available in the country and abroad, having a direct or indirect bearing on the objectives of the present investigation are reviewed in a chronological order under three broad headings namely:

1. Risk neutral farm plans
2. Studies related to instability in farm economy
3. Risk efficient farm plans

Commensurate with the objectives of the present study, only those studies which included dairy and other livestock enterprises along with crop enterprise in the formulation of optimum enterprise-mix have been reviewed.

2.1 STUDIES ON RISK NEUTRAL OPTIMUM FARM PLANS

Theorists and researchers have often found it convenient to assume that in many farm decision making situations all relevant information for making choice is perfectly known and hence the risk involved in taking the decision is neutralised. An optimum plan, thus worked out places the farmer in a neutral position.

Swanson (1955) by applying linear programming technique, brought out normative farm plan for a 320 acre mixed farm with crop and livestock enterprises having muscatine silt loam soil of Iowa state. Out of 320 acres, 20 acres were permanent pasture. In all, 6 cropping systems, three hog enterprises and two types of cattle feeding were considered as alternatives in the model. The author also introduced an income transfer activity in the model. Special activities for buying and selling of hay and grain and hiring of labour were also included.

Heady and Gilson (1956) considered a typical 160 acre farm in North East Iowa (U.S.A.) wherein dairy and poultry enterprises formed supplementary farm enterprises. By applying linear programming technique, optimum combination of livestock that would maximize the profit was brought out. Three types of optimum plan alternatives on the basis of efficiency levels such as, average, above average and below average were drawn. The analysis showed the decisive influence of resource limitation on the management practices.

Heady et al (1956) had taken crop rotation and capital availability as main factors that go hand in hand in building an optimum plan. He observed that the optimum farm plan for South Eastern Iowa (U.S.A.) conditions, could maximize the profits under limited capital with a cash grain rotation of two year corn and one year soybean. Forage crops found a place in optimum plan to the extent of 25 per cent only when unlimited capital availability was assumed. Consequently, dairy and poultry enterprise also entered optimum plan when unlimited funds were presumed. Many alternative optimum plans were worked out only when sufficient capital was made available which inversely goes to show that farmer with limited amount of capital has limited choice in choosing his enterprise combination.

Heady and Loftsgard (1957) worked out optimal farm plans for Cresco-clyde soils in North East Iowa, where relatively low grain yields on these soils were obtained. Livestock was considered as a supplementary enterprise and given more investment priority. All plans were restricted to forage produced on the farm whereas extra feed grains for livestock were purchased from the market. For all farm plans computed, the returns to each dollar invested were greater than 7 per cent. Consequently, if the farmers were willing or able to bear the risk, they could rationally borrow capital at 7 per cent interest rate to use any of the farm plans. Labour available on the farm was considered as limiting factor in designing many alternative farm plans. Labour hiring for small farm was not profitable at existing wage rate unless the size of the farm was increased to more than 160 acres and livestock handled with superior management.

Ladd and Easley (1959) and Krenz _et al_ (1960) applied variable price programme to arrive at step supply function of two different areas of Iowa. While Ladd _et al_ considered crop with dairy, hog and poultry enterprise for optimum plan, Krenz had taken only farm milk supply at various levels of technology.

Baker _et al_ (1965) using linear programming developed optimum combination of milk, hog, beef cattle, and crops on specialized and non-specialized dairy farm at different price level of milk and at selected farm situations at varied prices of hog, beef cattle, corn and labour. The place of study was Chicago milk market area. He studied the response of both the farm situations to changes in price of milk and concluded that though the response differed with the type of farming, by and large, for a given increase in price of milk there would be a large increase in the output of milk in the study area.

While studies which used linear programming technique in countries other than India, considered labour (Heady et al 1957) capital (Heady, 1956,1957) and management (Heady and Gilson, 1956) as important constraints for drawing optimum plans, in India, land and capital were given more weightage in arriving at optimum plans. Also, dairy animals were assigned the role of supplementing the farm net returns. The valuable findings of the past studies in India centre around the fact that dairy animals in a mixed farm economy not only increased productivity of the farm but also enhanced farm employment and income.

Johl et al. (1965) observed that net returns to fixed farm resources could be increased from Rs. 4658 to Rs. 6929 on the small farms and Rs. 11,671 to Rs. 13,971 on large farms after resource reorganization in sub-urban areas of Punjab. This meant an increase in farm income of 19.67 per cent on small and 40.17 per cent on large farms in the optimal plans over the existing plans. Wheat straw and gram grain were introduced in the matrix as intermediate products which made possible for dairy enterprise to enter into the optimal farm plans.

Gangwar (1966) explored the possibilities of increasing farm net returns and labour employment by proper allocation of available farm resources on cultivation holding in Kanjhawala Block. Linear programming was used to derive optimum plans for different categories of farmers. In the optimal plans, the area under cash crops increased, that under food crops decreased and the intensity of cropping also increased. Dairy enterprise could enter the optimal plans only if high milk yielding buffaloes were considered and borrowed capital was made available.

The results of various optimal plans indicated that even with the farm technology already in use, farm returns could be increased by 25 to 40 per cent with proper allocation of available farm resources. If borrowed capital was made available net returns could be increased by about 50 per cent. By changing over to improved agricultural practices, the net returns could be raised by about two and half times their value in the existing plan. The employment of human labour increased by about 50 to 90 per cent.

Ramanna (1966) attempted to investigate the potential for increasing farm incomes on subsistence and commercially oriented farms in Bangalore District with the existing resources and technological conditions and also with added resources and recommended technology. A sub-sample of ten farmers, five each from the two categories were selected from the sample of the farm management inquiry, Bangalore, using gross income, farm cash expenses, farm size and size of family as major criteria. Linear programming technique was used to estimate the optimal incomes on the selected farms.

Programming for the subsistence group resulted in an increase in the cropping intensity from 135.6 per cent in the present plan to 200 per cent in the optimum plan and 291 and 300 per cent respectively in the plans with recommended practice under limited and unlimited capital assumptions. In respect of the commercial group, cropping intensity on the garden land increased from 192 per cent in the present plan to 280 and 292 respectively in the current practice plans and 300 per cent in the recommended practice plans.

Johl and Kahlon (1967) developed the optimum plan for a mixed farming situation in Ludhiana district of Punjab. Though the optimum plan generated higher returns to fixed farm resources by 74.4 per cent, dairy enterprise could not enter into the optimal plan as a competitive enterprise. They tried introducing dairying as a fixed activity at levels of 2, 5 and 10 buffaloes, and found that the optimum plans generated less returns by 1.73, 5.6 and 9.88 per cent for the respective levels as compared to optimum plan without buffaloes. They concluded that it might be considered worthwhile to incorporate dairying at small scale to increase stability and regularity in farm income.

Sirohi and Gangwar (1968) explored the possibilities of increasing farm incomes by reorganisation of farm enterprises in Kanjhawala Block of Union Territory of Delhi. They used land, labour and capital restrictions with land transfer activity. The optimum organisation of farm resources was examined with and without inclusion of vegetable crops and dairy enterprises as well as with improved agricultural practices. The results showed that the dairy activity could enter the optimum plans when capital restriction was relaxed.

As an extension of their previous work, Dhawan and Johl (1969) applied variable price programming technique so as to locate the price of milk at which dairy enterprise could become profitable in comparison to crop cultivation. The results of the analysis showed that when price of milk was Rs. 0.70 per litre, dairy activity could not enter the optimal plan. It was only when this price was increased to Rs. 0.77 per litre that the dairy buffalo found a place in the optimal plan at a level of one animal. When the price of milk was increased to Rs. 0.81 per litre, the number of buffaloes jumped to 32 with 80.47 per cent increase in income whereafter there was no further scope of increasing the number of buffaloes. Later, when the analysis was carried out by including the high yielding crop varieties, only with the price of milk pegged at Rs 1.00 per litre, the dairy enterprise found place in the optimal plans at a level of four animals.

Singh (1970) developed optimal plans by combining crop and dairy enterprise with the help of linear programming technique in order to assess possibilities of increasing income on farms of different sizes in Etah district of Uttar Pradesh. He used two levels of technology namely existing and improved with three capital restricting categories. The results indicated that in all the optimal plans, the intensity of cropping was higher than existing plans. It was observed that with restricted capital, there was no change in the total number of buffaloes and with increased capital availability, the number reached maximum specified limit with programming under common practices of the area. With the relaxation of dairy capital, mean optimal income increased by 9.45 and 24.58 per cent in the optimal plan formulated with existing and improved level of technology respectively.

Johl (1972) analysed the shifts in production patterns of Punjab. The analysis revealed that the most common 'Paddy-wheat' rotation was comparable to dairy enterprise with crossbred cows yielding 1800 litres of milk per lactation at a price of Rs. 0.94 per litre. It was concluded that sooner the farmers start incorporating and expanding dairy enterprise into their production programme, better it would be in the face of cost-price squeeze in crop farming.

Dhawan (1973) studied the impact of new technology and varying product prices on optimum agricultural production patterns in Punjab. Linear programming was used to develop optimal production programmes and parametric programming to locate the effect of variation in product price on the optimal plans. The optimal plans developed with all possible constraints showed a marked shift in area from local to high yielding varieties because the latter was comparatively more remunerative. Dairy enterprise figured predominantly in all the plans when the price of milk was Re. 1.00 per litre. The most viable rotation was the one which included potato as one of the crops, when the rotation including potato as one of the crop activities was dropped from the analysis, dairy buffaloes entered as the most paying enterprise on all the farm situations in all the four zones of the State. It was also found that when the price of milk was raised to Re. 1.00 per litre, some area was shifted from wheat, paddy or cotton to fodders for feeding dairy animals.

Analysing the data for Uttar Pradesh, Pandey (1973) reported that bovine animals on an average received only about one-half and four-fifth of total required quantities of D.C.P. and T.D.N. respectively based on Morrison's feeding standard. Young cattle and buffalo stocks were the most poorly fed animals. Milking animals were generally better fed than rest of the animals.

The results indicated that in the optimal plans which permitted culling of unwanted animals, the net returns over fixed factors were about 5 per cent higher than the plans which did not allow culling in Western U.P. The corresponding figure for Eastern U.P. was about 7 per cent. The findings of the study advocated the comparative superiority of buffaloes over cattle for milk production in the State.

Gill and Gill (1974) conducted a comprehensive study on optimal plans for crop and milk production in Ludhiana district of Punjab. Dairying with crossbred cows and improved buffaloes was incorporated in the enterprise-mix of 12 farms of different sizes as per their resource endowments and adoption constraints. The results showed that on an average, per hectare return to fixed farm resources in case of dairying with crossbred cows and buffaloes were Rs. 8009 and Rs. 4965 respectively while it was only Rs. 2141.28 from crop farming. Dairying was found to be more paying than arable farming.

Kahlon *et al.* (1975) in their study observed that crop cultivation by Punjab farmers was not operated at optimum level compared to dairying. The optimum plans registered an increase in the number of crossbred cows. Milch buffaloes were eliminated from the optimum plans indicating that crossbred cows were more profitable than buffaloes.

Radhakrishnan and Sridharan (1975) employed linear programming technique to work out the optimum cropping pattern which a farmer could adopt in a pre and post development situation when long term loans were given in Kancheepuram taluk of Chengleput district of Tamil Nadu. They found that the maximum number of five milch animals could be maintained without reducing income from crops. They suggested that if veterinary services, marketing facilities for milk are provided all the farmers could take up dairying as a subsidiary occupation.

Das *et al.* (1975) studied the profitability of dairy farming with crossbred cows vis-a-vis grain production under typical rural conditions at National Dairy Research Institute, Karnal. For this purpose, one hectare each of fertile and irrigated land was put under milk production with six crossbred cows and arable farming with high yielding varieties of crops such as wheat and paddy at recommended level of crop-cum-milk technology. The analysis revealed superiority of dairy enterprise with a net income of Rs. 5858.35 per hectare over crop enterprise with Rs. 3462.96 as net income per hectare.

Radhakrishnan *et al.* (1975) used the input-output data for 90 farms situated Sarkarsamakulam block of Coimbatore Taluk, Tamil Nadu in order to explore the possibilities of maintaining the milch animals with the availability of fodder, labour and other resources. Linear programming model was used to arrive at optimum cropping pattern to suit the farming situation. The results revealed that the readjustment of cropping pattern to suit the farming situation, would earn 44.2 per cent additional income and a maximum number of five milch animals could be maintained by the farmers.

Saini and Sidhu (1975) estimated capital and credit requirement of different farming situations in Punjab with the help of linear programming technique. They observed that the increase in credit requirement per animal was more in case of medium farmers under existing situation.

Saini and Singh (1977) used linear programming technique to develop the normative plans for a farm situation in Punjab. The results showed that in the optimal plans at existing technology without borrowing, the farm income could be increased by 23.06 per cent over the existing plan and with relaxation of capital constraint income attained a 30 per cent increase. The optimal plans formulated at recommended level of technology with and without borrowing resulted in an increase in income to the tune of 10.24 and 115.66 per cent, respectively. The maximum increase in employment over the existing plan was 54.64 per cent in optimal plan at existing technology and 11.43 per cent at recommended level of technology whereas the medium term dairy capital needs were 21.37 and 288.39 per cent more under the respective optimal plans than the existing ones.

Saini and Sidhu (1977) formulated optimal plans by incorporating dairy enterprise on small, medium and large farms at the level of 2, 3 and 8 buffaloes, respectively for Malerkotla Development Block of Sangrur district (Punjab). The results showed an increase in returns to fixed farm resource to the tune of 61.14, 55.76 and 68.22 per cent on the respective farm situations over the existing plans. The higher returns were attributed to capital and labour intensive enterprises such as dairy, wheat and rice. It was concluded that incorporation of dairying into general farming resulted in more stable income.

Singh <u>et al</u>. (1977) by utilizing part of the data from a broad investigation conducted by National Dairy Research Institute in milk-shed area of Nabha, brought the impact of varying levels of dairy enterprise with crop farming in the context of augmenting income and employment potential of small farmers in Nabha and Samana tehsils of Patiala District. The results showed that in the optimal plans at existing technology without borrowing and with borrowing, the farm income showed only a marginal increase over the existing plan. On the other hand the optimum plans arrived at recommended level of technology, with borrowing, showed an increase of twice the existing condition. With regard to employment, existing technology seemed to be labour intensive resulting about 55 per cent increase in labour employment in optimal plan, whereas improved technology showed an increase of 11 per cent. The reverse observation was noticed in the case of capital utilization in optimal plans. Hence the study concluded that improved technology was more capital intensive than existing technology.

Verma and Pant (1978) derived two types of optimal plans, one with given number of buffaloes and other without any restriction on type of milch animals. The study was conducted on small, medium and large farms in the Phulera tehsil of Jaipur district (Rajasthan). On small farms, the returns to fixed farm resources were Rs. 3375 in the existing plan, which increased to Rs. 5218 in the optimal plan 11. On medium and large farms, the returns to fixed farm resources in the existing plans were Rs. 10,348 and Rs. 32,729, respectively. This increased to Rs. 22,521 and Rs. 22,857 in the optimal plan I and II on medium farms and Rs. 30,038 and Rs. 40,410 in large farms in the same order.

Bhatia (1978) studied the optimum combination of crop and livestock enterprises of small farms in Karnal District (Haryana) by using the linear programming technique. He observed that there was very little scope of increasing the net returns merely by reallocation of farm resources. The net returns increased only by 6, 10 and 3 per cent on group I, II and III, respectively. Only 1, 1 and 2 buffaloes entered the plans respectively. At improved level of technology with existing resource level, livestock could not compete with crops, but the net returns increased by about 58, 48 and 26 per cent in the respective groups.

With the addition of capital borrowing activity, there was a tendency towards dairy farming both at existing and improved level of technology and the net returns increased substantially both at existing and improved levels of technology.

It was further observed that at existing level of technology, buffalo was more paying than the cows, but at the improved level of technology, buffalo could not compete with crossbred cows.

Singh et al. (1979) analysed the data on economics of milk production in Haryana state and formulated the optimal enterprise combination using the linear programming technique. The State was divided into dry and wet zones representing Hissar and Rohtak Districts. The households were further categorised into three groups viz., as having upto 2 milch animals (Group I), 3 to 5 milch animals (Group II) and above 5 milch animals (Group III). The results revealed that the specialisation in a few crops gives higher income than diversification. When the milk price was Rs. 1.75 per litre, buffalo raising was found uneconomical on Group I and III of the dry zones and all the groups in the wet zone. When the milk price was raised to Rs. 2.25 per litre, the number of buffaloes included in the plan were 1.07 and 2.4 on Group I and III respectively in dry zone. The number of buffaloes in the optimum plan in the wet zone was 1.69 and 2.34 on group I and II. The study revealed that the farmers should maintain 2-3 buffaloes for higher farm income.

Haith (1979) developed linear programming model for a typical farm situation in Ithecca (USA) which focussed on the nutrient budget of the dairy farm and determined an optimal set of cropping, manure spreading, nitrogen application, herd size decisions subject to constraints on farm losses of nitrogen, phosphorus and eroded soil.

Singh and Jain (1979) explored the possibilities of introducing dairying with buffaloes and exotic cows and poultry enterprise on different synthetic farm situations in Ludhiana District (Punjab) The results indicated that in the kharif season, optimum cropping pattern shifted in favour of paddy, groundnut, American cotton and fodders at the cost of desi maize, cotton and sugarcane and in the rabi season in favour of wheat and fodder at the cost of barley and gram. In the optimal plans, the number of buffaloes remained at the minima (fixed) levels of 2,3 and 6 on the small, medium and large farms, respectively, whereas the number of exotic cows increased from nil in the existing plan to 3 in the optimal plan on small farm; and similarly from 1 to 7 on medium and from 1 to 9 on large farm situations. Despite the imposition of rotational maxima on dairy and some other enterprises, the returns to fixed farm resources could be increased by 33.22, 78.05 and 19.28 per cent on small, medium and large farms, respectively. The labour requirements increased by 43.55, 67.53 and 61.65 per cent on small, medium and large farms, respectively. The optimal plans, thus provided a sizeable volume of additional employment opportunities.

Reddy (1979) concluded in his study 'on optimum crop and dairy mix for farmers in Bangalore District' that reorganization of available resource use such as land, labour and capital (owned and borrowed) resulted in fuller utilization of land which was left fallow (both dry and wet) by all the categories of farmers. He also brought out the economics of dairy enterprise and its employment potential among small, medium and large farms. The return per rupee investment was the highest for cross-bred i.e. Rs. 1.50, than local cow which was Rs. 1.17 only. With one dairy cow unit, the employment potential for human labour was 106 mandays for small farmer and for medium farmers with one crossbred one local cow and one buffalo the employment potential was 111 mandays and for large farmers, the employment potential was 92 mandays.

Sirohi et al. (1980) examined the possibilities of increasing income and labour employment through the introduction of dairy and poultry enterprises on various size groups of land holding in Union Territory of Delhi employing linear programming technique.

It was observed that by introducing the dairy and poultry enterprises in the optimal plans, the net returns were increased by 165, 148 and 21 per cent on marginal, small and medium farms, respectively.

To see the place of dairying in the optimal plan, three types of optimal plans, one with crops alone, second by incorporating dairy only and the third by including both the dairy and the poultry enterprise were formulated. It was observed that dairying showed a limited scope for increasing farm incomes, whereas poultry was found to be a rewarding enterprise especially on marginal farms. But risk proneness of poultry enterprise and its marketing. Constraints for marginal farms have not been examined by the author.

Panday and Bhogal (1980) attempted to determine the extent to which the farm income and employment could be increased on typical mixed farms from the optimal crop and milk production plans derived by using the common and improved production technologies. The data pertained to a cluster of five villages of Narona centre in district Aligarh for the year 1976-1977. The linear programming was used to bring optimal plans for small, medium and large farms.

For small farm the optimal plan by using only common production process without keeping any dairy animal the levels of farm income and employment declined by 24 and 30 per cent respectively, under improved technology there was an increase of 13 per cent in farm income and reduction of 26 per cent in employment. However, with the introduction of buffalo, under common practices, the farm income increased under the optimal plans by 15 and 5 per cent, 54 and 39 per cent and 92 and 74 per cent when the number of buffaloes (desi) was increased to 1, 2 and 3 respectively. In the optimal plans with improved production processes, the corresponding figures were 71 and 9, 120 and 45 and 168 and 79 per cent with the inclusion of 1, 2 and 3 high yielding buffaloes, respectively.

The optimal plans with common production processes on medium farms promised an increase in the farm income to the tune of 33, 54 and 60 per cent and that of the employment to 21, 58 and 96 per cent when the buffaloes (desi) entered in the plan numbered 2, 4 and 6 respectively. The levels of farm income were further enhanced by 80, 114 and 125 and that of employment by 30, 69 and 107 with the enterance of 2, 4 and 6 high yielding buffaloes, respectively, in the optimum plan with improved production processes.

Large farms showed little scope for increase in farm income with desi buffaloes or without buffaloes under common production processes. But under improved technology with high yielding buffaloes 2, 4 and 6 the income increased by 44, 58 and 70 per cent and employment increased by 21, 44 and 68 per cent respectively.

Further, the large scale adoption of improved crop production technology on the typical mixed farms complements the milk production activities through the increased availability of crop byproducts. The authors did not include borrowing activity in the model to examine the impact of relaxation of capital constraint.

Bhatia and Gangwar (1980) attempted to examine the prospects of increasing income and employment on small farms in Karnal area (Haryana) through dairying. Linear programming technique was used for developing the optimum farm plans. The results of the study indicated the existence of marginal scope for increasing the farm income by simply reorganizing the resources. Farm income could be substantially increased by adopting improved technology in the case of both crops and livestock. The increase in net returns was 50, 47 and 26.35 per cent on farms below one hectare, between one and 2 - 19 acre with own tubewell and between one and 2 - 19 acre having canal irrigation respectively at improved technology. The study further revealed that dairying provides additional employment for human labour on small farms with the additional availability of capital. The increase in the use of human labour was 35.14, 116.26 and 114.14 per cent at existing technology and 156.52, 153.29 and 170.18 per cent at improved technology on the above mentioned three categories of farms respectively.

Gill (1981) studied the existing farm plans and optimal adjustment policies by using linear programming technique for the Punjab state. It was observed that at the existing level of technology without borrowing, dairying could not compete with crop enterprises and thus did not appear beyond prescribed minima in any of the zones. When the borrowing of capital was resorted to buffaloes entered the optimal plans of small, medium and large farms in varying numbers in zone I and III, whereas it could find favour only on small and medium farms in zone II. However, when the prices of milk were increased by 10 per cent, the optimal plans welcomed more buffaloes on all farm situations.

At the recommended level of technology, buffaloes could not enter the optimal plans beyond prescribed minima in any of the zones, even when the prices were increased by 30 per cent. However, crossbred cows appeared in the optimal plans on small and medium farms in zone I and only on small farms in zone II and III. It was further brought out that buffalo milk prices need to be increased by 47 and 61 per cent and cow milk prices by 35 and 48 per cent over the base price of milk on medium and large farms, respectively, so as to get the dairying incorporated in the optimal plans.

Handique (1981) applied linear programming to develop the optimum dairy and crop enterprises in the tribal pockets of Assam and Meghalaya. A comparison of the existing situation with the optimal plans indicated the readjustment needed in the cropping pattern and resource allocation to maximise profit. The study revealed that dairy enterprise entered the optimal plans in a very limited manner. The composition of livestock product-mix registered sizeable changes in favour of dairy enterprise, when new technology associated with borrowed capital brought in crossbred cows in the normative plan. Similarly substantial acreage allocation in favour of capital intensive crops like sugarcane, paddy, jute and vegetables materialised in the optimal plans when constraints on technology and capital was relaxed. The study concluded that the relaxation of capital constraint and subsequent substitution of low value enterprises would result in substantial augmentation of both income and gainful employment.

Saini (1982) observed that in Patiala district of Punjab dairy enterprise is an important alternative to diversify the arable farms to increase the income and employment potential. He further observed that if the existing resource endowments were properly allocated among the prescribed enterprise-mix, there was immense possibility of increasing the farm income through optimisation of resources on all categories of farms. Further, improved practices of crop and milk production could increase the income significantly on all the farm situations studied. The borrowed capital too showed its marked impact on income under the existing and the improved level of technology. The capital borrowing proved to be of immense importance in terms of credit effect on farm incomes in the optimum plans with improved technology. In general, it was concluded that the adoption of improved technology coupled with adequate credit facility dynamises the entire gamut of income potential.

Saini (1984) in this study in Haryana State, considered four farm plans for each of five zones under existing and improved technology with and without capital borrowing for crop-dairy enterprise combination.

Under plan 'A' with existing technology without capital borrowing, dairying with cows was found to be unprofitable. However, the reallocation of resources in optimum plan increased the net returns to the tune of 2.58 to 46.78 per cent on small farms, 6.24 to 47.68 per cent on medium farms and 7.4 to 73.64 per cent on large farms. With capital borrowing plan B, the number of buffaloes increased in all the farm situations. The increase in the net return varied from 15 to 73 per cent, 22 to 72 per cent and 44 to 95 per cent on small, medium and large farms respectively in different agro-climatic zones. In plan C, under improved technology without capital borrowing buffalo could not compete with crossbred cows. The increase in net returns ranged between 39 to 199 per cent, 57 to 166 per cent and 87 to 129 per cent on small, medium and large farms, respectively. In plan D with capital borrowing, the number of crossbred cows increased in all farms situations. The increase in net return varied from 70 to 284 per cent, 106 to 285 per cent and 193 to 293 per cent on small, medium and large farms, respectively.

From the foregoing review of the studies under risk neutral farm plans, there seems to be a general consensus that crop-livestock integration exhibits substantial potential for increasing employment and income, especially on small farms. However all the studies highlighted the common limitation of assuming risk neutrality in the farm activities which resulted in fragmentary plans appropriate only for short time horizon. With the result, stable farm plan decisions could not be attained.

Also all the optimum plans brought out earlier with a few exceptions of (Gill, 1981, Saini, 1982) could not bring optimum livestock unit because of want of methodological refinement of mixed integer programming.

Cattle and buffalo are considered as fixed asset as land. In practice, they are having value in exchange, which were utilized for crop expenditure of the season.

Improved technology for dairy activity was built up on recommended feeding practices. Recommended feeding practices were assumed to provide least-cost combination which need not be true always in practice.

The limitations of previous studies were rectified by the present study to some extent by following, in the first place, mixed integer programming for bringing out maximum net return under risk neutral farm condition and in the second place the maximum net return which would bring minimum variation (risk efficient farm plan). These two types of optimum plans, were compared with existing farmers' plan.

2.2 STUDIES ON INSTABILITY ON FARM ECONOMY

The last three decades have witnessed significant growth in total cereal production in India. A log trend regression fitted to data yields an annual growth rate of 2.7 per cent for years 1952-53 to 1977-78, omitting the draught years 1965-66 and 1966-67

(Shakuntla Mehra, 1981). But these increase in average production have been accompanied by increased production instability. The coefficient of variation of total cereal production was 5.85 during 1968-1978, though, modest by international standards, yet can cause substantial price instability which immediately affects the farm families who retain high proportion of production for family consumption (Hazell, 1982).16/

Studies related to the source of instability in farm activity and optimum plans incorporating the stochastic element in the production surface would be helpful in planning at farmer's level and framing policies at government level to destabilize the disturbing forces in the wake of developmental activities.

Many studies both descriptive as well as model building have been taken up, in and outside India to find a close and consistent relationship between various farm activities that go hand in hand in stabilizing the farm returns. Various methods were followed to measure and incorporate variability in the farm plans, yet rational plans on the basis of such measurement is quite intractable. The reason is risk or uncertainty which like the term utility, is a subjective term. To measure this subjective term by one single measure is

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16/ Hazell B.R. Peter (1982) Instability in Indian Foodgrain production. International Food Policy Research Institute. Research Report 30, page 9.

like measuring the length by a rubber ruler which stretches as we measure.

Swanson (1957) analysed data for 27 years to answer problems of land valuation, crop insurance, choice of crop and related farm business matters. He made an attempt to measure yield fluctuations over the years for technological changes. Non availability of historic cost data made him to use gross returns instead of net returns. He assumed that costs did not vary much over the years.

A more systematic analysis of the variability was attempted by Carter and Dean (1960). Measures of variabilities in prices, yields and returns were computed from 20 to 40 years historic data and a more objective measurement of uncertainty associated with various crops and cropping systems in California, U.S.A. was provided by them. They used variance difference method to isolate the systematic component from the random component in the time series data on prices, yields and returns. Variability of individual crops were derived exclusively from state yield, price and return series. Costs were synthesized by making use of budget studies to allow for use of net returns. This study, though important from the point of view of methodology for the estimation of variability, did not make use of it in farm planning.

Malya and Rajagopalan (1964) utilized time series data of rainfall, gross cropped area, cropping pattern starting from 1905 to 1952, to explain the extent of uncertainty. They used coefficient of variation for this purpose. Farmer's response to rainfall was studied by cropping pattern and they concluded that farmers showed high preference for survival by devoting a large proportion of their acreage to low yielding inferior millets.

Misra *et al.* (1964) found that poultry, dairy and fisheries were enterprises taken up by farms as a defence against flood in Cuttack area. Thus diversification was resorted to protect against the natural calamities.

Kahlon and Johl (1964) attempted to establish the extent of variation in acreage of important commercial and food crops in relation to the variation in yields, prices and rainfall over their growing periods. The data pertained to the period 1951-52 to 1961-62 for Ludhiana district. They found that the variance in the post-harvest prices had more influence over variance in the acreage of different crops than with that of rainfall and yields.

Gupta (1964) measured variability of 14 selected crops (1950-51 to 1961-62) in Varanasi district in U.P. using variability index. It refers to year to year variation in crop yields, prices and income as percent of the current level which was average of last 5 years. He found that the index of price variability was lower than that of yield and gross income variability for all the crops.

Vyas and Rakhral (1964) studied uncertainty and crop planning in the Bhavnagar District of Saurashtra region with data from 1950-51 to 1960-61, using coefficient of variation as a measure for uncertainty. They concluded that variability in yield and gross income were more than that of variability in price.

Patil and Hiregoudar (1964) analysed the effect of weather uncertainty on the yields of paddy and management decision in Bangalore District. The data used belonged to years starting from 1929 to 1960. Coefficient of variability was calculated as a measure of uncertainty. To know the effect of rainfall on yields, they used Cobb-Douglas type of production function and found that irrigation exercised more significant influence on yields than rainfall.

Apte (1964) studied cropping pattern of Osmanabad district of Maharashtra State in relation to rainfall, prices and farmer's decisions which were governed by three main considerations namely, desire to achieve self-sufficiency in cereals, availability of seeds for cash crops and biological hazards. Farmers were observed to discount the income from cash crop very heavily on account of biological hazards rather than prices.

Where, C is the cost of x^{th} stock at p^{th} price and

E = expected cost which was calculated for x^{th} stock at $\bar{p}^{th}$ price (expected price)

It is then left to the customer to decide what combination of 'yield level' and 'risk level' (Min V) he wants (Danzig, 1966). Thus Portfolio theory is an efficiency criterion that identifies a set of investment plans that minimise variance fof given levels of expected wealth from which well defined classes of decision makers can find the expected utility maximizing solution.

Markowitz's problem was to select an optimal portfolio of stocks under a budget constraint. Thus X_i being the amount of the stock, i in the portfolio, the feasible set was derived by $\sum X_i = V$, V being the total fixed cost of the portfolio. Given the high variability of the outcome of this kind of investment, it was not possible to maximise the expected value of the portfolio at a prescribed future date t.

$$\bar{Z} = \sum_i \bar{C}_i X_i,$$

$\bar{C}_i$, being the expected value of the stock, i at that time. Since C_i was the true value, $Z = \sum C_i X_i$ was a random variable with mean $\bar{Z}$ and variance σ_Z^2. He proposed to maximise

$$F = \bar{Z} - A \sigma_Z^2$$

Where A was risk averse coefficient whose value depended upon the personal character and mood of the investor.

Assuming

$$\bar{Z} = E\,\bar{C}_i\,X_i(\bar{C})\,\lambda_i \text{ and}$$

$$\text{given } V_{ij} = E\,(C_i - \bar{C})\,(C_j - \bar{C}_j)$$

$$\text{then } \sigma_z^2 = 1/2 \sum_i \sum_j V_{ij}\,X_i\,X_j$$

and F is a quadratic form in X_i. As the matrix of the V_{ij} was positive semi-definite, F was a convex and had one optimal value under the constraint, $\sum_i X_i = V$. Risk was measured by the variance of the outcome of the decision, and the utility function was a weighted sum of expectations and variance.

Though there are reasons to accept the simplified way in which portfolio theory identifies efficient investment plans, its slow acceptance in agriculture field was due to lack of computational capacity of available quadratic programming algorithms which could be used to derive the EV set. Most recently, agricultural economists have applied portfolio theory to an increasing number of diverse problems. Scott and Baker (1972) applied portfolio theory on an Illinois corn and soyabean farm adding Baumols safety first criterion. Still other applications were by Barry and William (1976) to contracting problems with credit constraints, by Whitson, Berry and Lacewell (1976) to a vertical integration in ranch management, and by Buccola (1977) to deciding on tomato contracting alternatives.

Heady and Candler (1958) developed a new modified simplex method to handle the problem of risk in agriculture production. By taking variance as an adequate index of the net return variability, the authors standardized the net revenue of farm activities for risk programming analysis. Special risk programming equations to the standard simplex equations were added. The authors considered the observations to be random and limited their analysis to get E-V (expected return-variance) efficient plans from which the farmer could choose one plan.

Camm (1962) formulated alternative plans for a 100 acre farm using the quadratic programming technique incorporating the element of risk likely to occur from yield and price variations. These alternative plans yielded different levels of returns and the farmer was asked to select one keeping in view the fixed costs involved.

Stovall (1966) developed a theoretical model with two real activities to revive research interest in return variability. The total variance function was obtained and the contribution of each enterprise to the total variance was worked out. By this way he showed some implications of the effect of enterprise selection on total return variance in farm planning.

How and Hazell (1968) by utilizing the time series data on costs and returns of a vegetable farm in

Western New York illustrated a procedure for quantifying variability in farm returns. They incorporated return variance as one of the constraint. They obtained a set of variance-covariance coefficients from the gross margin series assuming these to be the realistic estimates of the true values and that these were independently and normally distributed.

Singh and Zilberman (1984) in their study brought the impact of price uncertainty on land and fertilizer allocations among crops in Punjab State. Quadratic risk programming model was used for this purpose. The model is as follows:

The revenue R_i per unit of X_i crop activity was assumed to be stochastic in nature and follow a normal distribution with mean C_i and variance δi^2. It was further assumed that the revenue R_i of each crop activity has an associated utility.

$$U(R_i) = 1-e^{-\emptyset R_i}$$

Where

$\emptyset$ = risk aversion coefficient of the farmer.

As the revenue at each point of time was assumed to be normally distributed, the expected utility of revenue was maximised if one was maximised.

$$E(R_i) - \tfrac{1}{2}\, Q\, \delta i^2 \quad \text{or}$$

$$C_i - \tfrac{1}{2}\, Q\, \delta i^2$$

R_i is random in nature, therefore $E(R_i)$ is equal to C_i

The maximization of total expected utility of revenue was achieved by maximizing

$$C'X - \frac{1}{2} \alpha X'VX$$

Subject to

$$AX \leq B$$

Where,

$C' (C_1, C_2 \ldots\ldots\ldots Cn)$

V = Variance-covariance matrix

The problem was to choose $X \geq 0$ which maximize $C'X - \frac{1}{2} \alpha X' VK$ subject to $AX \leq B$ with the help of programming considering the different values of risk aversion coefficient.

With the help of above model the authors concluded that the risk caused by price instability resulting in variation in the income from the crop affected the allocation of land and fertilizer among crops. Also, they concluded that the existing land and fertilizer allocation pattern is away from the efficient E-V frontier. It implies that the existing cropping plan is inefficient in the sense of minimum risk portfolio.

2.2.2 MOTAD Model approach to measure risk.

Hazell (1971) suggested the minimization of total absolute deviations (MOTAD) programming procedure. The approach was similar to E-V analysis, but instead of minimising variance for any gross margin total absolute deviation of total gross margin (A) was minimised. An E-A (Expected return-mean deviation) opportunity locus replaced the usual E-V opportunity locus. MOTAD programming had an advantage for skewed outcome distribution. His linear alternative, which, while retaining most of the desired features of the quadratic model could be readily solved on conventional L P models with the parametric option. His criterion MOTAD is as follows: He defined C_{hj} ($h = 1-S$, $j = 1 \ldots n$) as the observation of forecasts of the outcomes of the unitary level of the activity j under the state of nature h, and

$$g_j = \frac{1}{S} \sum_h C_{hj},$$

The mean absolute deviation of the total outcome of the portfolio X ($X = X_1 \ldots \ldots X_j \ldots \ldots \ldots, X_m$) was

$$A = \frac{1}{s} \sum_h \sum_j (C_{hj} - g_j - \quad) X_j$$

A was an unbiased estimate of the population mean absolute income deviation. The model was

$$\text{Minimize} \quad \sum_h \quad \bar{Y}_h$$

$$\text{such that} \quad \sum_j (C_{hj}' - g_j) X_j + Y_h \geqslant 0$$

$$h = 1 \text{ to } S$$

$$\sum_j g_j X_j = \bar{Z} \quad (\bar{Z} = 0 \text{ to unbounded})$$

$$\sum_j aij \; X_j \leqslant bi$$

$$(i = 1, \ldots \ldots \ldots m)$$

Where, aij 's matrix was the standard linear programming matrix of non-risk constraints and Y_h was the negative part of the deviation for the state of nature h. The efficiency locus, thus, generated was obviously not identical to (E-V) locus, but, according to Hazell the differences were not so great as to definitely reject the model as a reasonable approximation of the quadratic programming.

The approach used by Hazell to bring efficient farm plan has been successfully applied to different types of problems such as the trade off between expected returns and risk among corn belt farms (Brink _et al._ 1978), evaluation of alternative peanut policies (Nieuwoult _et al._ 1976), the return risk trade off associated with tomato production in North Western Ohio (Schurle _et al._ 1979), Mexican vegetable exports equilibrium studies (Summion _et al._ 1975) stable food grain production plan for India (Hazell, 1982) farm plans for draugt prone area of Bijapur (Mruthunjaya, 1976) and flood areas of Assam (Kalitha, 1980, Bhowmick, 1982).

2.3.3 Risk efficient Farm Plans.

Farming in India is full of risk and uncertainty. The main source of risk and uncertainty prevailing in crop and livestock production are output, price and yield instability. The main factors responsible for price fluctuations are unstable national and international commodity prices and shifts in Government policies. Under such conditions, producers do not only aim to maximize income but also to reduce risk.

Recognition of risk in farmer's decisions in crop production and its measurement is of recent origin and only a few empirical studies have been, thus far, carried out in India which blended time series data to ascertain the instability in agriculture and cross sectional data to know the input and output of various farm activities, specially, crop and livestock enterprise.

Mruthyunjaya (1976) in his study on drought prone farms in Bijapur district, Karnataka, attempted to examine the nature and degree of instability and to suggest an efficient cropping and supplementary enterprise system for stability and growth in arid agriculture. Primary data from 113 farmers and secondary data from published sources were used for this study. Statistical tabular analysis, deterministic linear programming and parametric risk (Stochastic) programming techniques were used.

The results indicated that agriculture in Bijapur was highly unstable and risky, characterised by high fluctuations in both crop yields and prices. The results showed that in most of the optimal plans on small farms the entire farm area was put to use. However, on large farms, around 60 per cent of the land remained slack in most of the plans due to rigid constraint of bullock labour. In the existing plans, all the available land was put to use on both small and large farms to get some income.

The net returns were higher and more stable in the final optimal plans with dairy than the optimal plans without dairy. On small farms the net returns were Rs. 4559 with standard deviation of Rs. 592 and on large farm, it was Rs. 17222 and the standard deviation was Rs. 2966 only. The results showed that mixed farming with dairy activities could not only increase net returns but also added stability to farm income - human labour and capital became the major constraints when sufficient dairy activities were suggested in the optimal plans along with crop activities. In general, it was observed that when gross margin was parameterised, risk increased much faster than farm returns in all the farm plans.

Kalitha (1980) carried out a detailed investigation in the flood free parts comprising 90 per cent of the rainfed areas of Assam plains in 1978-79 with a view to explore the possibility of deriving higher farm income by studying risk efficient production decisions under various farm situations. The analysis of the risk efficient production plans indicated that on small, medium and large synthetic farms, (both jute and sugarcane zones) the risk associated with existing levels of gross margins declined with the shift from the existing to the improved levels of technology.

The investigation of the possibilities of earning higher than the existing levels of gross margin brought out that from the view points of profitability and stability of farm incomes, crop + cattle + poultry + goat farming alternative was the best production policy decision for the risk averters as well as for the risk preferers in the study area.

Bhowmick (1982) in his study in Kamrup district of Assam worked out optimal plans and studied the pattern of cropping, farm returns and labour employment with various combination of crop and livestock enterprises. He found that the coefficients of variation of yield of most of the crops were high which indicated a high degree of instability in flood prone district of Kamrup. Due to optimisation, small farms increased cropped area whereas medium farms did not. Area under potato increased in optimum plans for all farms. Liberal availability of credit increased total cropped area but did not increase the number of livestock enterprise. By and large, inclusion of livestock enterprise not only reduced the risk but also increased the farm returns under resource optimisation.

All the three studies used constant cost concept to arrive at gross margin. Though suitable time series data for cost of production of various farm activities rarely exist, yet weightage given to current cost figures by index number could bring the gross margin/unit of farm activity near to reality. In this study, instead of constant cost of production weighted cost of production was used to arrive at gross margin.

Also time series data for milk production of cattle and buffalo of the region are not available. Earlier studies either assumed zero risk in dairy activities (Mruthyunjaya, Kalitha) or estimated on assumed milk production data (Bhowmick). In this study milk production estimates were calculated on the basis of growth rate of milch animals of each category, like, crossbred cow, Hallikar cow and buffalo for each taluka.

The importance of covariance between crops and between enterprises was not brought out in any of these studies which was attempted in the present study.

2.3.4 Utility Models to measure risk.

Utility based models have been the most widely used in investigating behaviour of decision makers under uncertainty by economists, psychologists and statisticians. Specific agricultural applications of utility theory have been made by Officer and Halter (1968), McArthur and Dillion (1971), Lin (1973), Francisco and Anderson (1972), Webster (1977) and Bond and Wonder (1980).

Officer and Halter dealt with decision on fodder reserves for drought conditions and Lin dealt with the selection of cropping systems. In both these studies, a reasonable correspondance between actual decisions made and those predicted by expected utility theory was observed. McArthur and Dillion studied optimal stocking rates and Webster applied this rule to pesticide use. Bond and Wonder applied the technique to obtain the certainty equivalents of four different gambles which represent local risks that farmers confront. The main finding of their study, however, is that while risk aversion is the most prevalent risk attitude among the Australian farmers the average degree of risk aversion is not very high.

In the context of developing countries, the major works have been reported by O'Mara (1971), Dillon and Scandizzo (1978), Herath (1980), Binswanger (1980) and Singh (1980). O'Mara and Herath studied the decision to adopt new technology by farmers in Brazil and Sri Lanka respectively. They observed a close association of the theoretically predicted decisions and actual decisions. Dillon and Scandizzo, studying a group of Brazilian farmers using utility model showed that risk attitudes to income changed substantially when subsistence consumption was at risk.

Binswanger reported results of estimating risk attitudes of 240 farmers in India. He used the interview technique to derive the certainty equivalents and an experimental approach with real pay offs. His study showed that at higher pay offs, most individuals are moderately risk averse.

The main disadvantage in utility theory is the difficulty in correctly eliciting the utility functions.

2.2.5 Safety First Models to measure risk.

Some heuristic models that have come into increasing prominence as an adjunct to the expected utility theory are the safety first models. In these models risk is defined as the probability that the stochastic variable in question assumes a value below a predetermined critical minimum or a disaster level.

Scott and Baker (1972) used Portfolio theory on Illinois corn and soyabean farm adding Baumols' safety first criterion. The model developed by them was

Maximise

$$Z = U'X - d\,X'\,W_x$$

subject to

$$AX \leq B$$

where

U'	=	a vector of the incomes for the activities
X	=	the vector of activities
d	=	the scalar (risk aversion coefficient)
W	=	Variance-covariance matrix of activity incomes
A	=	Matrix of the input coefficients
B	=	Vector of resources restriction

The mean expected income was computed from the annual observation on prices and yields over the past 10 years.

Roumasset (1976) incorporated safety first rules into some lexico-graphic decision models to explain fertilizer use by rice farmers in Philippines. Barry and Robinson (1975) employed the safety first criterion along with stochastic dominance and showed that his rule leads to choices similar to choices made using other criteria such as Baumol's (1963) expected gain-confidence limit criterion.

A basic need in most safety-first model is the specification of an exogenous disaster level. This is a nebulous concept and hence specification becomes arbitrary.

2.2.6. Game theory model to measure risk.

Game theoretic decision criteria have been proposed in decision making under uncertainty. One of the earliest applications of game theory models was by Heady and Dillon (1961). The decision problem investigated was the selection of cattle feeding programmes by 77 farmers in Iowa for the 1957 season. It was noted that in general, the specified game theory model had descriptive value only for a small proportion of entrepreneurs. The normative implications of the model was assessed via the maximin criterion, principle of insufficient reason and regret criterion. It was suggested that the farmers could have increased their expected profit by 21 per cent if they used these three criteria.

Aggarwal and Heady (1968) also applied the above models for selection of cropping enterprises, application of fertilizers and determining marketing strategies.

McInerney (1967) used game theoretic criteria for farm planning under risk in the context of programming models.

Game theory is more suited to situation in which actors and their adversaries plan consciously, analytic examples relating agriculture in the literature are not easy to find (Herath, 1982).

2.2.7 Multi Model approach for risk measurement.

Kennedy and Franciasco (1971) developed farm production plans using both Hazell's MOTAD model as well as Focus Loss Constrained Programming (FLCP) techniques. They found that the three different formulations of MOTAD and FLCP used in their study performed equally well. They, however, contended that if the necessary time series data on gross margin were available, the MOTAD formulations were easy to run and had the advantage of flexibility in interpretation.

Boussard (1976) reviewed different approaches of decision making under risk and uncertainty in agriculture. He considered portfolio selection approach, chance constrained programmes and game theory approach as alternatives. He argued that the quadratic programming was theoretically appealing but very much difficult to apply from the practical point of view. He considered some linear approximation approach specially Hazell's MOTAD model to be much important for practical purposes, though it appeared to lack theoretical support.

Anderson (1976) critically reviewed several methods of modelling decision making under risks to note inter-relationship among alternative methods for various purposes. The alternative methods considered by him included expected utility maximization lexicographic ordering and stochastic dominance. He argued that the E-V approach was a more satisfactory measure of risk compared to E-A approach but asserted that as the matter permitted ready incorporation in the linear programming formulations, it had pragmatic appeal.

Taucer (1983) proposed Target MOTAD model. This model is modification of MOTAD called Target MOTAD. Here a two attribute risk and return are taken into consideration. The model is as follows:

1. Max. $E(Z) = \sum_{j=1}^{n} C_j X_j$ . . . . (i)

subject to

2. $\sum_{j=1}^{n} a_{kj} x_j \leqslant b_k$ . . . . (ii)

3. $T - \sum_{j=1}^{n} c_{rj} x_j - y_r \leqslant 0$ . . . . (iii)

$r = 1 \text{ to } s$

4. $\sum_{r=1}^{s} P_r Y_r = \lambda$ . . . . (iv)

$\lambda = m \text{ to } 0$

Where, equation (i) maximizes expected return of the solution set,

Equation (ii) fulfills the technical constraints,

Equation (iii) measured the revenue of a solution under state r,

If the revenue is less than target T, the difference is transferred to equation (iv) via variable Y

Equation (iv) sums the negative deviation after weighting them by t their probability of occurring P_r

This model though theoretically appealing is yet to be tested under various farm conditions for its efficacy.

From the foregoing review of literature, it is amply clear that while considerable potential exists for increasing income and employment through optimum resource allocation and enterprise-mix, there is hardly any literature for risk efficient farm plans with crop-dairy enterprise mix for dry farming areas which could serve guidelines in many developmental activities both at regional as well as farm levels. Keeping this in view, the present study was designed to bring out the risk efficient farm plans under various alternative production choices in the Bangalore district which is a dry farming area.

CHAPTER – 3

DESCRIPTION OF THE STUDY AREA

DESCRIPTION OF THE STUDY AREA

Karnataka is the eighth largest state in India both in area and population. It is situated on the western edge of the Deccan Plateau of the Indian Union and lies between 11.5° and 19° north latitudes and 74° and 78° east longitudes. The state is bounded by Kolhapur, Sangli, Solapur, Osmanabad and Nanded districts of Maharashtra State and Goa in the north, Hyderabad, Mahbubnagar, Kurnool, Ananthapur and Chitoor districts of Andhra Pradesh in the East, Salem and Nilgiri districts of Tamil Nadu in the South-East, Cananore district of Kerala in the South and Arabian sea in the West.

Physiographically, the State is divided into four regions, namely, coastal region, Malnad chilly country lying east of the Western ghats edge, the Northern trappeanless undulating plateau, and southern broad archean undulating plateau.[17]

Further, the state has been sub-divided into ten agricultural zones based on the rainfall pattern and other characteristics like major soil types, elevation and vegetation. Among these ten zones, five zones are dry zones namely North east dry zone, North dry zone, Central

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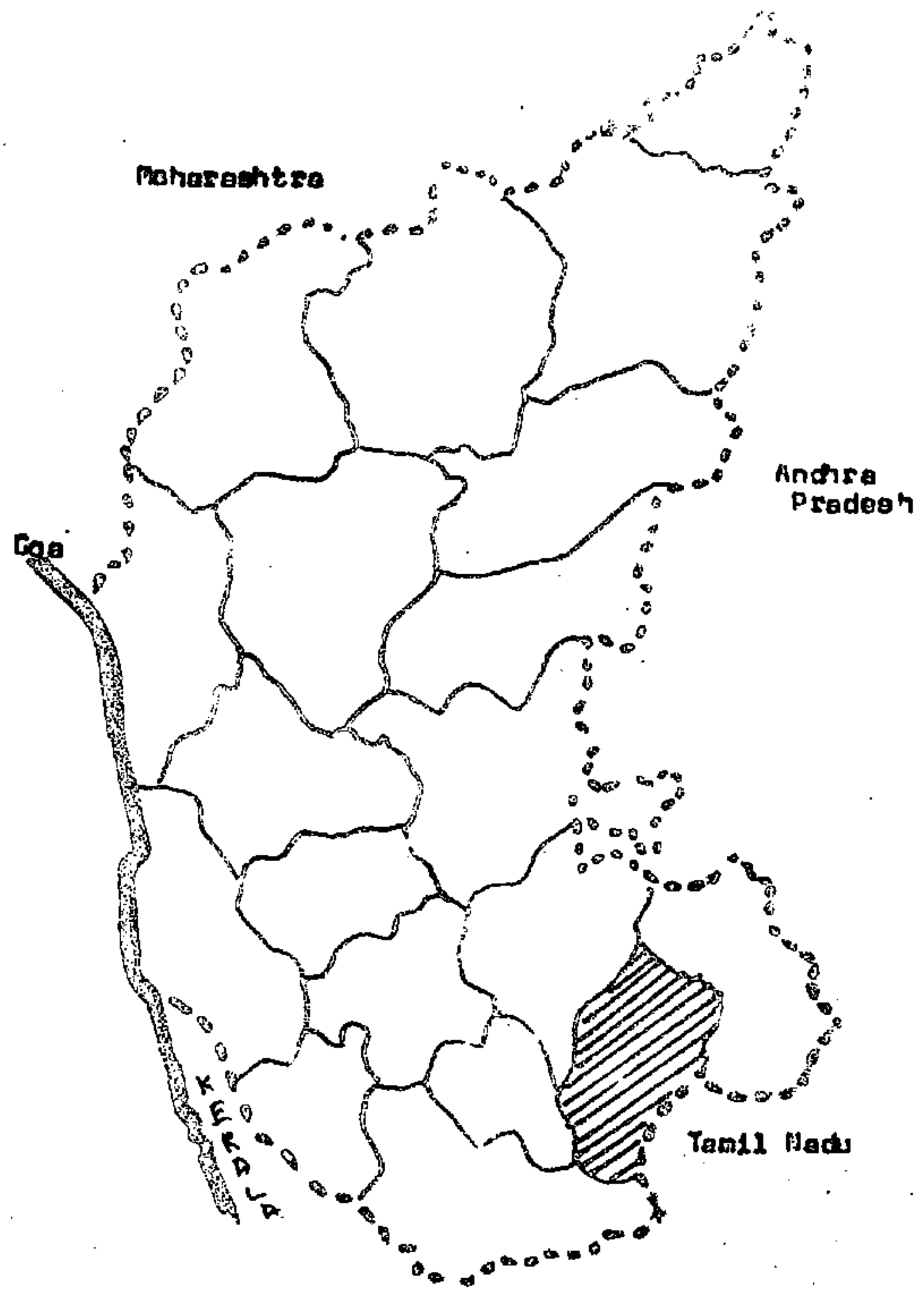
17/ Puttaswamiah (1980) Economic Development of Karnataka - A Treatise in continuity and change, Vol.1, page 11, Oxford Publishing Co., New Delhi.

POSITION OF BANGALORE DISTRICT IN KARNATAKA STATE



Indian boundary

State boundary

District boundary

Selected district - Bangalore

dry zone, East dry zone and South dry zone. These dry zones occupy 64 per cent of the total geographical area of 10.4 million hectares of the state and 72 per cent of the net cultivated area of the State.

Bangalore district, which is the location of the present investigation, represents dry south eastern zone, a plateau with soils mostly red loams with fairly good moisture retentive capacity. The normal rainfall is 794 mm and the break up under different periods is 408 mm during June to September as South West monsoon, 215 mm during October to December as North-East monsoon, 12 mm during January and February as cold weather period rains and 159 mm during March to May as hot weather period rains. The altitude of Bangalore and its surrounding area is as high as 921 meters and the temperature is modest ranging from 20.5°C in December to 27.3°C in April. The Bangalore district consists of the state headquarters, Bangalore city and eleven talukas.

The district is endowed with great potential for development. Judicious exploitation of the resources of the district calls for a detailed study about farm production pattern including dairying and other economically viable avocations.

3.1 AREA AND POPULATION

Bangalore district covers an area of 8008 sq. km which is 4.17 per cent of the total area of the State. It includes 2470 inhabited villages accounting for 9.21 per cent of the total villages in the State (Table 3.1). But this district is comparatively more thickly populated when density of population per sq.km is taken into consideration. Its density of population is as high as 615 per sq.km which is almost three times the State average. This high density is mainly due to the metropolitan and industrial character of the Bangalore city. The rural population of the Bangalore district constitute only 44.56 per cent of the total population of the district as against 87 per cent in the State.

3.2 LAND UTILIZATION

Of the total geographical area, only 47.3 per cent of the area was cultivated in the district. The percentage of net area cultivated for the State was much more than the corresponding figure for the district (Table 3.2). Forests and fallow land constituted 15.84 per cent and 8.2 per cent of total area of the State respectively. However, the corresponding figures for the district were only 10.03 and 6.91 per cent of the total area, respectively. The proportion of permanent pasture land to total area is 16.75 per cent for Bangalore district as against only 7.44 per cent for the State as

Table 3.1: Area and Population of Bangalore District and Karnataka state.

Particulars	Karnataka state	Bangalore district	Percentage to the total of the state
Area (sq.km)	191791	8003	4.17
Population (000s) (1981 census)	37145	4922	13.29
Density/sq.km.	193	615	
Percentage of rural population	87.35	44.56	
No. of inhabited villages	26826	2470	9.21

Source: The Times of India - Directory and Yearbook (1983) page 67.

Table 3.2: Land utilization statistics of Bangalore district and Karnataka state (1979-80)

(000' hectares)

Particulars	Karnataka state	Bangalore district	Percentage to total state area
1. Total geographical area	19059 (100)	802.0 (100)	4.21
2. Net area cultivated	10306 (54.07)	407.4 (47.3)	3.90
3. Forest area	3019 (15.84)	80.5 (10.03)	2.67
4. Fallow land	1563 (8.2)	55.5 (6.91)	3.55
5. Not available for cultivation			
i) Barren and uncultivated land	875 (4.6)	48.0 (5.98)	2.52
ii) Land put to nonagricultural use	974 (5.11)	68.7 (8.56)	3.06
6. Other cultivable waste	597 (3.13)	13.52 (2.01)	2.26
7. Permanent pasture	1418 (7.44)	112.64 (16.75)	7.94
8. Land under misc. trees crop groves etcetra not included in net area sown	307 (1.61)	16.54 (2.46)	5.38

Source: 1. Karnataka State Agricultural Department.
2. Times of India - Directory and Yearbook (1981)

Note: Figures in Parentheses are Percentages to total geographical area.

a whole. Other areas, namely, area not available for cultivation, cultivable waste and land under trees and groves are very meagre both for the district as well as the state as a whole.

3.3 LAND HOLDINGS AND OPERATED AREA

Excluding the Bangalore city, the eleven talukas consist of mostly rural area. But the distribution of land among farming households is inequitable since about 71 per cent of the total operational holdings below 2 hectares handled about 33 per cent of the total operated area (Table 3.3). The remaining medium and large farmers having more than 2 hectares as operational holdings cultivated as much as 67 per cent of the total operated area of the district.

3.4 SOURCES OF IRRIGATION

Though Karnataka State has two rivers and 21 riverlets, Bangalore district does not have river irrigation. It was noted that in Bangalore district, the total irrigated area (as in 1979-80) was 73290 hectares, of which, 37296 hectares were under tank irrigation, 29324 hectares under wells, 4316 hectares under canals and 2248 hectares under other sources of irrigation. Thus, in Bangalore district only 17.98 per cent of the cropped area was under irrigation as against 21 per cent in the State as a whole.

Table 3.3: Land holding pattern, number of operational holdings and area operated in Bangalore district and in Karnataka state.

Farm size group (in hectares)	Bangalore District		Karnataka State	
	Percentage to total		Percentage to total	
	Number	Area	Number	Area
0.1 to 1.0	45.01	12.40	33.40	5.6
1.01 to 2.0	25.86	20.63	23.30	11.6
2.01 to 4.0	18.94	27.32	21.50	20.1
4.01 to 10.0	8.63	26.21	16.60	34.0
10.0 and above	1.56	13.44	5.20	28.7
Overall	100.00	100.00	100.00	100.00

Source: K.Puttaswamaiah (1980) Economic Development of Karnataka. A Treatise in continuity and change, Vol.1, page 801.

3.5 CROPPING PATTERN

The cropping pattern of the State as well as Bangalore district are set out in Table 3.4. It is observed that the proportion of area allocated under the principal crops like ragi, paddy, jowar, wheat, maize, minor millet, groundnut, sugarcane, mulberry fodders crop and others varied considerably in the state and district.

Ragi is the staple food in the district. About 47 per cent of the cropped area was kept for growing ragi as against the state average of 8.83 per cent. Next crop which occupies a major area in the district as well as in the state was paddy. Nearly 9 and 10 per cent of the total cropped area was allotted for paddy crop in the district and state respectively. Jowar cultivation was almost negligible in the district which occupied about 16 per cent of the total cropped area of the state so also Bajra and cotton cultivation were not popular in Bangalore district.

Major oil seed cultivated was groundnut which occupied nearly 5 per cent and 7 per cent of the total cropped area in the district and state respectively. Sugarcane and chillies, the major commercial crops occupied 1.12 per cent and 0.68 per cent of the total cropped area in the district, though the state average was little more than this.

Table 3.4: Cropping pattern for Bangalore District and Karnataka State.

Name of the crops	Percentage share of crops to total cropped area	
	Karnataka state	Bangalore district
Paddy	10.58	8.97
Ragi	8.83	47.15
Wheat	2.91	0.11
Jowar	15.75	0.10
Maize	1.46	2.64
Minormillets	3.50	2.38
Bajra	4.66	-
Tur	2.93	0.97
Gram	1.46	0.11
Chillies	1.46	0.68
Groundnut	7.37	5.05
Sugarcane	1.46	1.12
Cotton	9.32	-
Coconut	1.65	1.49
Mulberry	0.86	3.02
Fodder crops	N.A.	3.64

Source: Statistical Abstract of Bangalore District (1979-80) and Bureau of Economics and Statistics, Government of Karnataka.

Bangalore district is one of the four districts in the state where mulberry leaf production for rearing silkworm is favoured on irrigated land. On an average 3.02 per cent of land was kept for this leaf production whereas state average was only 0.86 per cent. Fodder crops mainly napier and rhodes grass on irrigated land and para grass in water logged areas occupied about 3.64 per cent of the total cropped area in the district.

3.6 HORTICULTURAL CROPS

The district had 29265 hectares of land under various horticultural crops, of which, plantation crops and spices, ranked first occupying an area of 13679 hectares followed by fruits and vegetables with an area of 7953 ha. and occupied the second and third ranks respectively. However, grape production in the district was the highest among all the districts of the state. Among vegetable crops, potato was grown in an area of 1472 hectares. It was observed that there was scope to increase the area under all types of fruits and vegetables in the district. Out of the total area of 13679 hectares under plantation crops, coconut occupied an area of 10649 hectares and commercial flowers were grown in 347 hectares of cultivated land.

3.7 LIVESTOCK POPULATION

The livestock, an integral part of a diversified agriculture in India, consists of cattle, buffaloes, sheep, goats, pigs, horses, poultry, donkeys etc. Together they make a significant contribution to the state and national income.

It was noted that some of the good draught breeds of India, namely Amrithmahal and Hallikar which form the main source of draught power in the state are being developed for both draught and milk production, in the district.

Table 3.5 gives the number of livestock population and its density in the district and state. It is interesting to note that Bangalore district had the largest cattle population among all other districts which accounted for about 8 per cent of the total cattle population of the state. Further, the density of cattle population was also very high as compared to overall average of the state. The density of cattle in Bangalore district was about 94 per square kilometre as against about 47 per square kilometre in the state.

Moreover, it was observed that according to 1977 census, there were 755461 cattle heads, of which, 171122 were milch cattle which accounted for only 22.65 per cent of the total cattle population in the district. Of the total cattle population in the state about 36 per cent were milch cattle.

On the other hand, buffalo population was not as high as cattle population in the district. It constituted 5.50 per cent of the total buffalo population of the

Table 3.5: Livestock population in Bangalore district and Karnataka state.

(1977 census)

Particulars	Karnataka State		Bangalore District	
	Number 000's	Density/ sq.meter	Number 000's	Density/ sq.metre
Total cattle	9080	47.35	755	94.40
Milch cattle	3238	16.88	171	21.36
Total buffalo	3126	16.30	172	21.50
Milch buffalo	1820	9.49	73	9.12
Sheep	4343	22.65	339	42.40
Goat	3086	16.10	187	28.40
Poultry	9311	45.55	1065	133.00

Source: State Animal Husbandry Department state. There were 172129 buffaloes in the district, of which, 72801 were the milch buffaloes accounting for about 42 per cent of the total buffaloes in the district. Buffalo density was also higher for the district as compared to that of the state. It was observed that the cattle served as the main source of draft power in agriculture while buffalo contributed a larger proportion to the total milk production in the district. However, with the introduction of crossbreeding programme, crossbred cows have started becoming an important source of milk production in the district.

Systematic efforts in cattle development in the district began with the extension activities initiated by the National Dairy Research Institute in the year 1952. This was later followed by the introduction of Intensive Cattle Development Programme in 1966 and now it is also being carried out by Karnataka Dairy Development Corporation. Controlled breeding has been taken up through A.I. using semen of Jersey, Holstein Friesian and Red Dane bulls for cows and Murrah bulls for buffaloes. Frozen semen technique was introduced in the district during the year 1977.

Through a network of agencies, the present bovine population of 1567 villages in the district are being provided timely insemination and veterinary aid. In the year 1980, 40598 inseminations were recorded in these villages.

3.8 SHEEP AND GOAT

Next to bovine population, sheep and goat population assumes special significance in the district. As per 1977 livestock census, the number of sheep in the district was 339216 and that of goat 186651 accounting for 7.80 per cent and 6.0 per cent of the total population of the state respectively. The important four breeds of sheep in the state and the district are Bellary, Deccani, Hassan and Bannur (Mandya). In Bangalore district, sheep population consist mostly of Bannur breed used both for meat and wool production. Among sheep and goat, dual purpose sheep was more densely populated. The goat population was distributed sparsely throughout the district. By and large, it was seen that density of livestock population was relatively very high in the district as compared to that of the state.

3.9 POULTRY

Bangalore district stands third in the state for raising poultry birds. The state poultry farm in the district has made considerable progress during the last two decades. The district has about 1065000 poultry birds, which accounted for 11 per cent of the total birds in the state.

3.10 MARKETING CHANNEL FOR FARM PRODUCE

There are three regulated markets for grain and other crops in the district. The details of marketing of farm produce including that of sheep and goats are being recorded regularly in these markets situated in three talukas of the district.

Milk is channelized through 194 milk producers' Cooperative Societies spread over 8 talukas of the district which is collected, processed and marketed by Bangalore Dairy. This dairy started functioning in the year 1966 initially with the aid of UNICEF with the primary aim of supplying milk to the vulnerable section of the urban population. For selling cocoons, five regulated markets are being operated in different parts of the district.

These organised markets for crop and livestock produce play an important role in marketing farm produce. Monthly reports of prices of farm produce by the Agricultural Marketing Board help the farmers to know the fluctuating trend of prices of various commodities.

Keeping in view, the existing valuable resources of the densely populated district, the present study has been taken up with a view to helping the farming community through developing viable and optimum farm production plans. This study brings out integrated farm plans which cover major farm activities of the district having a dry zone. To this end, the present study is expected to provide guidelines to the farmers having similar resource situations in the state.

CHAPTER - 4

METHODOLOGY

METHODOLOGY

Bangalore district of Karnataka has witnessed great strides in the field of dairying with crossbred cows during the last two decades. To calibrate farm plans with crossbred cows which bring increased and stable income (Dass, 1975) to the farmers, Bangalore district provided a suitable background which prompted its purposive selection for the present study.

The data utilized for the present investigation are based on an earlier survey on 'Economics of crossbred cattle in Bangalore' conducted during 1979-80 by the Division of Dairy Economics, Statistics and Management of National Dairy Research Institute, Karnal and its Southern Regional Station at Bangalore. The sampling design of the study and data collection procedure are presented in brief in the following sections. This is followed by the analytical framework adopted in the present study.

4.1 SAMPLING FRAME

The sampling frame consisted of multi-stage stratified random sampling technique. To have homogeneous study area, organized milk marketing area which covered eight talukas out of eleven in the district were selected[18/] which formed the first strata. The second strata constituted of 51 villages selected at random according to probability proportional to the number of crossbred cattle in each taluka. The ultimate sample of 259 cattle keepers was randomly selected from the sample villages according to probability proportional to the number of cattle keepers in each village.

Commensurate with the objective of the present study, 240 sample cattle keepers with cultivable land were utilised for further analysis and for developing the optimal crop-dairy enterprise combination. The selected cattle keeping households were post-stratified on the basis of operated land holding into marginal, small, medium and large categories by applying the cumulative cube root method.[19/] The sample design with distribution of the selected households among the various farm sizes are presented in Table 4.1.

4.2 DATA COLLECTION

In order to accomplish the objectives of the study, two types of data were needed, namely, i) primary data from farm households regarding technical requirements of inputs and output of farm activities

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18/ The talukas covered in this study were Bangalore North, Bangalore South, Anekal, Hosokote, Ramnagara, Channapatna, Devanahalli and Doddaballapura.

19/ Singh, Ravindra (1975) "On optimum stratification for proportional allocation" Sankhya, 37, series C Part 1: 109.

Table 4.1: Distribution of sample households

Particulars	Marginal farm (upto 1.74 ha)	Small farm (1.75 to 2.550 ha)	Medium farm (2.551 to 6.433 ha)	Large farm (above 6.433 ha)	Total
Total number of households in the selected village	2381	1027	343	80	3831
Total number of sample household	53	85	70	32	240

and details of resource constraints on the farm, and ii) secondary time series data about crop production, total area under each crop, milk production and the prices of farm produce in the district.[20/] The number of years taken for this study was 11 years (1969-1979).

Primary data collection was done adopting the cost accounting method using specially structured and pretested questionnaries. Trained investigators visited the selected households for collection of data regularly, once in a month, for the period from July 1979 to August 1980. Information on demographic particulars of sample households, details of cattle and buffalo such as age of the animal, age at first calving, order of lactation, stage of lactation, date of calving, dry period, vaccination, procurement prices of feeds and feeding pattern and marketing of milk were collected during the monthly visits. Data on milk yield of individual animals and feed inputs were recorded by actual weighment and other particulars by direct observation and careful enquiry. Further, detailed information regarding fixed farm resources including land and its utilisation pattern, labour and capital assets were

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20/ Suitable time-series data corresponding to the representative farm basis were not available to evaluate the fluctuation in farm gross margin. For this reason the analysis about risk efficient farm plan is based on a direct examination of time series data on aggregate food grain milk production and other farm production - Please see: Shakuntala Mehra, (1981) "Instability in Indian Agriculture in the context of the New Technology" Research Report 25. International Food Policy Research Institute, Washington, D.C.

also collected. Similarly, information on cropping pattern, farm operations, input-output structure of all the farm enterprises along with crop and dairy management practices were recorded.

The secondary time series data to fulfil the requirements of the study in terms of finding out the fluctuations in income from each enterprise for the district were collected partly from published sources and partly from the records of various state departments (Bureau of Statistics and Economics, State Agricultural Department, State Animal Husbandry Department, State Sericultural Department) for a period of 11 years from 1969-1979.

4.3 ANALYTICAL FRAME WORK

The major tools of analysis consisted of the Deterministic and MOTAD[21/] (Hazell, 1971) models of Linear Programming in order to develop the optimum farm production plans (risk neutral plans) and the risk efficient optimum plans.

4.4 RISK NEUTRAL OPTIMUM PLAN - MODEL I

Mixed Integer Programming[22/] was used to obtain the optimal plans under Model I.

21/ Minimisation of Total Absolute Deviation.

22/ James L.Kuester, Job H.Mike (1973) "Optimisation Techniques with Fortran" Page 60-89. McGraw Hill Book Company.

The specification of profit maximization[23] model was as follows:

Maximize

$$Z_{ikl} = \sum_{i=1}^{n} C_i X_i + \sum_{k=1}^{12} C_k D_k + \sum_{l=1}^{3} C_l S_l$$

$i = 1 \quad 1 \ldots\ldots\ldots n$

$k = 1, 2, 3, \ldots\ldots 12$

$l = 1 \text{ to } 3$

Subject to

$$\sum_{i=1}^{n} \sum_{k=1}^{12} \sum_{j=1}^{3} a_{ij} X_i + a_{kj} D_k + a_{lj} S_l \gtreqless b_j$$

$$j = 1 \text{ to } m$$

$$X_i \geqslant o \quad D_k \geqslant o \quad \text{and } S_l \geqslant o$$

Where

Z_{ikl} = Total returns to fixed farm resources from farm activities

C_i = return to fixed farm resources for i^{th} crop activity

X_i = level of i^{th} crop activity

C_k = return to fixed cost for k_{th} dairy activity

D_k = level of k^{th} dairy activity

23/ The objective function was to maximise returns to fixed farm resources on the farm in an annual cycle and these returns were measured by deducting variable expenses from the gross income. This was in consonance with the observation of Dhawan and Kahlon (1977) who demonstrated the superiority of return to fixed from resources over gross return concept while optimizing the objective function.

C_1 = return to fixed farm resources for 1^{th} sericulture activity

S_1 = level of i_{th} sericultural activity

b_j = available of j^{th} resource

and a_{ij}, a_{kj} and a_{1j} = input of b_j th resource for i^{th}, k^{th} and 1^{th} activity.

4.5 SYNTHETIC FARM SITUATION

Budgeting technique was used for establishing input-output coefficients for various farm enterprises. As considered by earlier studies, the average farm concept was used for estimating optimal farm plans. (Day *et al.*, 1962; Dhawan and Kahlon, 1977; Kahlon, 1980; Sirohi *et al*, 1980; Gill, 1981; Handique, 1981; Saini, 1982).

4.6 ACTIVITIES IDENTIFIED FOR THE PROGRAMME

Farm activities or processes which bring major income components to the farm families were considered for building up optimal plan. Non-farm activities of the farm families like business, service etcetra were not considered on the ground that they did not compete with farm activities for resources. The following are the activities considered for the programme situation.

4.6.1 Crop Production.

Total production of crop in a year - cereals or others - differ with the type of land, variety and season. Hence three seasonal crops, viz., kharif, rabi and summer crops grown on two types of land, irrigated and unirrigated, covering two varieties, improved and local, were considered for crop activities. All the crops grown in each farm group in the study period were included. A list of crops included in the study is given in appendix

4.6.2 Crop selling activity.

For those crop activities which were undertaken for home consumption and sale of the surplus produce, selling activities were included. Thus selling ragi, paddy, maize in three seasons at the prevailing market prices constituted separate activities.

The coefficients appended with each crop activity consisted of a positive land, labour and capital coefficient in each of the constrained situation, crop selling activities contained a positive price figure in profit equation and a negative coefficient in capital constraints.

4.6.3 Dairy enterprise.

Animal keeping in farm families is ubiquitous. With the introduction of crossbred cows in the farm economy, dairy farming is being changed from a way of life to one of farm business enterprise.

The decisions regarding what breed and what type of animal to keep and at what price the farmer should look for marketing milk or animals is very crucial in the wake of multipurpose dairy animals.

Four groups of animals were identified on functional basis as follows:

<u>Group 1</u>: Animals kept for only milk production, that is, 365 days the milch animal competed for the farm resources with other farm activities.

<u>Group 2</u>: Animals kept for milk production and bovine marketing. This means that these animals were kept for less than 365 days on the farm.

<u>Group</u> 3: Dry animals which were disposed off during the year under study.

<u>Group 4</u>: Young stock above one year upto pregnant heifer stage.

4.6.4 Milk selling activities.

Milk selling in all the three seasons, namely, kharif, rabi and summer, adds to the capital availability within the farm. Seperate activities for cow milk and buffalo milk selling in three seasons were considered. These activities are linked with milking animals of each category.

4.6.5 Cocoon production.

Mulberry growing and silk-worm rearing were farm activities undertaken by a large number of the farm families of all categories in the district.

Three varieties of cocoons usually produced formed three separate activities. They were, small or local variety, medium variety, large or bivoltin variety. These activities had positive land, labour and capital coefficients.

4.6.6 Added activities.

Most of the farmers hire human labour, bullock labour or borrow capital at one time or the other to supplement the limited resources available with them for productive activities. To what extent the farmer can hire labour or borrow money and at what rate he can afford to pay the interest on borrowed capital is useful information for explaining the optimum farm plan for each category of farm situation. Hence labour hiring, bullock pair hiring and capital borrowing were added in the model as detailed below.

4.6.7 Labour hiring activities.

In all, three labour hiring activities were incorporated in the model. They were kharif period I (July) rabi period I (November), summer period I (March). Labour hiring activities were incorporated in many earlier studies also to fill the shortfall of family labour during sowing and harvesting times (Johl and Kahlon, 1963; Ramanny 1966; Singh, 1966; Dhawan and Johl, 1967; Sirohi and Gangwar, 1968; Kahlon _et al_.,1975 Sidhu _et al_., 1975; Dhawan and Kahlon, 1977; Mruthyunjaya and Sirohi, 1979; Sirohi *et al*., 1980; Gill, 1981; Handique, 1981; Saini, 1982).

4.6.8 Bullock hiring activities.

To supplement the bullock labour during peak periods, three bullock hiring activities were used, namely, kharif period 1 (July), Rabi period 1 (November) and summer period 1 (March).

4.6.9 Capital borrowing activities.

Three capital borrowing activities, namely, kharif capital, rabi capital and summer capital were used to supply additional capital for working expenses of crops and other farm activities. This method has been adopted by several other workers in the past (Gangwar, 1966; Singh, 1966; Sirohi and Gangwar, 1966; Kahlon *et al*., 1975; Sirohi *et al*., 1980; Gill, 1981; Handique, 1981; Saini, 1982).

4.6.10 Ragi straw buying activity.

Farmers utilize the byproducts of food grains, such as ragi straw, paddy straw and maize kadbi for feeding the cattle and buffalo and draught animals. It is the general practice in Bangalore district that mostly ragi straw is purchased as and when the stock of grain byproducts gets exhausted. Hence in the plan, ragi straw buying was included as an activity.

4.6.11 Transfer activities.

To obtain fuller utilization of working capital, the capital transfer activities were incorporated in the model (Sidhu *et al.*, 1975; Singh, 1978; Reddy, 1979; Gill, 1981; Hendique, 1981; Saini, 1982). Thus the excess of kharif capital was made available in rabi and that of rabi capital to summer and summer capital to profit equation by three transfer activities.

4.7 IDENTIFICATION OF CONSTRAINTS OR RESTRICTIONS IMPOSED ON THE FARM PLAN - LAND

Irrigated and unirrigated land which were either owned or rented in, during the three agricultural seasons were taken as maximum for the year. Rented out and land under trees and problem lands were excluded from operated land available for the season. Thus four land constraints viz. kharif irrigated, kharif unirrigated, rabi irrigated[24/] and summer irrigated lands were included in the model. Symbolically, the constraint equation is expressed as.

$$A_{igjf}\ X_{igjf} + A_{ijf}\ S_{ijf} \leq A_{jf} \quad \ldots\ldots \text{(iii)}$$

Where,

A_{igjf} = land for i^{th} crop of g^{th} variety in j^{th} season on f^{th} farm

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24/ Since the study area is mostly monocropped, there is no rabi or summer unirrigated land.

X_{igjf} = area under i th crop of gth variety in j^{th} land of f^{th} farm

A_{ijf} = land coefficient for i^{th} sericulture activity in j^{th} season on f^{th} farm

S_{if} = area under i^{th} sericulture activity on f^{th} farm

A_{jf} = area available in j^{th} type of land on f^{th} farm

i = 1 to n, j = 1 to 4; i = 1 to 3; g = 1 to 2;

f = 1 to 4

4.8 LABOUR

Different seasons have different potentials in labour employment, so also different enterprises. Since dairy and sericulture enterprise also need labour throughout the year, the entire year was divided into six periods. Six periods were kept as six constraints - kharif period I (July) and period II (Aug./September and October) rabi period I (November) and period II (December January and February), summer period I (March) and period II (April, May and June).

To know the availability of labour input, family members participation in these three production activities namely crop, milk and cocoons were taken from the recorded data. Accordingly, the average availability were generated as per type of farming for the year and

For all the three activities, crop, dairy and sericulture, labour coefficients were in terms of adult male units which were worked out on the basis of the prevailing wage rate.[25/] The equation for labour constraint is as follows.

$$L_{igj'f}\, X_{igj'f} + L_{kj'f}\, D_{kj'f} + L_{lj'f}\, S_{lj'f} - L_j^{h} \leq L_{j'f} \quad \ldots\ldots\ (iv)$$

Where,

$L_{igj'f}$ = Labour coefficient for i^{th} crop of g^{th} variety in j' period on f^{th} farm

$X_{igj'f}$ = level of i^{th} crop activity of g^{th} variety in j'th period of f^{th} farm

$L_{kj'f}$ = labour coefficient for k^{th} dairy activity in j'th period on f^{th} farm

$D_{kj'f}$ = level of k^{th} dairy activity of j'th period on f^{th} farm

$L_{lj'f}$ = labour coefficient for l^{th} sericulture activity in j'th period of f^{th} farm

$S_{lj'f}$ = level of l^{th} sericulture activity in j'th season on f^{th} farm

L_j^{h} = labour hiring coefficient in j'th period

$L_{j'f}$ = labour available in j'th period on f^{th} farm

$i = 1$ to n; $k = 1$ to 12; $l = 1$ to 3; $j' = 1$ to 6;

$g = 1$ to 2; $f = 1$ to 4

25/ The ratio for convertion were 0.66 male equivalent for one adult female labour and 0.5 for male child labour.

4.9 BULLOCK LABOUR

As was the case with human labour, availability of bullock pairs for draught power was a constraining factor for the timely farm operations. Parallel to the human labour constraints, bullock labour constraints also had a six periods. The equation for bullock labour constraints is of the following form.

$$B_{igj'f} \quad X_{igj'f} + B_{Ij'f} \quad S_{Ij'f} - B_{j}^{h}, \leqslant \quad B_{j'f} \quad . \; . \; . \; . \; (v)$$

Where,

$B_{igj'f}$ = Bullock labour coefficient for i^{th} crop of g^{th} variety in j' period on f^{th} farm.

$X_{igj'f}$ = level of i^{th} crop activity of g^{th} variety in j'th period on f^{th} farm

$B_{Ij'f}$ = bullock labour coefficient for I^{th} sericulture activity in j'th period on f^{th} farm

$S_{Ij'f}$ = level of I^{th} sericulture activity in j'th period on f^{th} farm

B_{j}^{h} = bullock labour coefficient for hired bullocks in j 'th period

$B_{j}^{'f}$ = bullock labour available in j'th period on f^{th} farm

i = 1 to n; g = 1 to 2; j' = 1 to 6;

I = 1 to 3; f = 1 to 4

4.10 CAPITAL

Capital generated, mobilized and channelized are the three important phases in utilization of this crucial factor of production. Almost all the research findings underlined the scarcity of capital as the single major limiting factor in the developmental activities of farming community.

The capital coefficient for crop activities were generated by taking into account: (1) expenses on land preparation, on seed and its treatment; (2) cost of farm yard manures and fertilizers; (3) expenditure on plant protection materials; (4) irrigation and contract charges; (5) charges on hired implements; (6) annual repair charges on implement and machinery, and (7) hire charges of cart etc. for marketing the produce.

For dairy activities the items included in the variable costs were: (1) expenses on purchased feeds and fodder; (2) veterinary charges on curative and preventive diseases; (3) artificial insemination service charges; (4) interest on value of cattle-shed and building (5) interest on value of animal; (6) depreciation on animal and cattle-shed, and (7) other miscelleneous charges like minor repairs etcetra.

For cocoon production activities the capital coefficients consisted of: (1) cost of cultivating mulberry leaves; (2) expenditure on purchased leaves;

(3) egg value; (4) hired charges for equipment, and (5) annual repair or replacement of equipment.

The other activities, namely selling activities had market value/unit of activity as capital coefficient. Since selling activities added capital availability in the corresponding season they had negative (-) sign and (+) buying activities, hired labour charges had positive sign with corresponding market price as capital coefficients.

Symbolically the constraint could be expressed as follows.

$$C_{igj''f}\, X_{igj''f} + C_{kj''f}\, D_{kj''f} + C_{\ell j''f}\, S_{\ell j''f} + C\,L_{j''}^{h} + CB_{j''}^{h} + CRS_{j''}^{b} + CR_{j''}^{b} + CP_{j''}^{b} + CCM_{j''}^{b} - C_{j''}^{b} - CR^{s}_{j''} - CP^{s}_{j''} - CM^{s}_{j''} - CCM^{s}_{j''} - CBM^{s}_{j''} + T_t \leq C_{j''f} \quad . . . . (vi)$$

Where,

$C_{igj''f}$ = capital coefficient for i^{th} crop of g^{th} variety in j" season on f^{th} farm

$X_{igj''f}$ = level of i^{th} crop activity of g^{th} variety in j"th season on f^{th} farm

$C_{kj''f}$ = capital coefficient for k^{th} dairy activity in j"th season on f^{th} farm

$D_{kj''f}$ = level of k^{th} dairy activity in j" season on f^{th} farm

$C_{\ell j''f}$ = capital coefficient for ℓ^{th} sericulture activity in j "th season on f^{th} farm

$S_{1j''f}$ = level of 1^{th} sericulture activity in j"th season on f^{th} farm

$CL^{h}_{j''}$ = capital coefficient for labour hiring activity in j"th season

$CB^{h}_{j''}$ = capital coefficient for bullock hiring activity in j"th season

$CRS^{b}_{j''}$ = capital coefficient for ragi straw buying activity in j"th season

$CR^{b}_{j''}$ = capital coefficient for ragi buying activity in j"th season

$CP^{b}_{j''}$ = capital coefficient for paddy buying activity in j"th season

$CCM^{b}_{j''}$ = capital coefficient for cow milk buying activities in j"th season

$C^{b}_{j''}$ = capital coefficient for capital borrowing activities in j"th season

$CR^{S}_{j''}$ = capital coefficient for ragi selling activity in j"th season

$CP^{S}_{j''}$ = capital coefficient for paddy selling activity in j"th season

$CM^{S}_{j''}$ = capital coefficient for maize selling activity in j"th season

$CCM^{S}_{j''}$ = capital coefficient for cow milk selling activity in j"th season

$CBM^{S}_{j''}$ = capital coefficient for buffalo milk selling activity in j"th season

T_t = capital coefficient for th transfer activity

C_{j*f} = capital available in j^{th} season in f^{th} farm

i = 1 to n; g = 1 to 2; j^* = 1 to 3; k = 1 to 12;
I = 1 to 3; f = 1 to 4

4.11 SPACE FOR DAIRY ANIMALS

Investment on cattle-shed constituted sizeable proportion of the total investment, the major proportion being the dairy animal. Both from the point of view of investment and space, this constraint was imposed for limiting the expansion of dairy enterprise (Kalitha, 1980). Space for each type of animal was allotted according to animal units[26/] (Patel, 1981).

Space constraint equation is:

$$S_{kf}\, D_{kf} \leq S_f \qquad \ldots\ldots \quad \text{(vii)}$$

Where,

S_{kf} = space coefficient for k th dairy activity on f th farm

D_{kf} = level of k th dairy activity on the f th farm

S_f = total space available on f th farm (square metre)

26/

Crossbred milch animal	=	1.40
Local milch animal	=	1.00
Milch buffalo	=	1.25
Heifer	=	0.75
Youngstock more than six months	=	0.50
Youngstock less than six months	=	0.33

4.12 MINIMUM REQUIREMENT

Food-grains such as ragi, paddy and maize and milk and by products like ragi-straw, paddy-straw, maize khadiby, and grain fodder such as napier were considered both for farm needs and market sale. While foodgrains and milk were constrained to a definite minimum level, fodder was kept as more than or equal to zero.

4.13 RESTRICTION ON NUMBER OF YOUNG STOCK

To ensure more of adult animals than young stock in the optimum plan, restrictions were imposed on number of adult cows and number of adult buffaloes as more than or equal to zero. Adult animal had positive coefficient (+1) and young stock had negative coefficient (-1).

4.14 PREPARATION OF INPUT-OUTPUT COEFFICIENTS

The actual quantities of various inputs required for growing different crops and raising different animals were used as input coefficients. Input coefficients were computed with respect to land, labour, bullock labour, variable cost and fodder for animals.

The output coefficients referred to the per unit returns to fixed farm resources obtained from an activity. These were derived by multiplying the total output (both main and byproducts) by its price and deducting the operating costs incurred on its production. The input-output coefficients of crops at recommended level of technology was obtained from Department of Economics, University of Agricultural Sciences, Bangalore. For dairy enterprise, the recommended level was prepared by taking least cost ration as mentioned else where (3.16.1) and was finalized in consultation with Scientists of National Dairy Research Institute, Bangalore.

4.15 PRICES

The average market prices of products and inputs received and paid respectively by the respondents were used in the study.

4.16 DEVELOPING TECHNOLOGICAL MATRICES

In the present study, two sets of matrices were developed. One, at the existing level of technology based on the data collected from the sample farms and the other at recommended level of technology. For crop activities the package of recommendations of University of Agricultural Sciences, Hebbal, Bangalore was relied upon. For dairy activities, the improved technology at field level consisted of crossbred cow or upgraded buffalo which are fed economically covering nutritional requirement. Since this information was not readily available, least cost ration was formulated.

4.17 LINEAR PROGRAMMING TECHNIQUE FOR LEAST-COST FEEDING OF DAIRY ANIMALS

Feed has been consistently observed as the most significant factor influencing milk yield (Jacob *et al.*, 1971; Aul *et al.*, 1974; and Patel *et al.*, 1976 and Gangadharan, 1978). Furthermore, feed cost being major item in the cost of milk production (Panse *et al.*, 1961; Puri and Singh, 1964; Ram *et al.*, 1976; and Patel *et al.*, 1976), formulation of economic feeding schedules for dairy animals is of utmost importance to the farmer.

Selection of an optimum feed mixture for the milch animals envisages consideration of several nutritional constraints. The feeds and fodder provided to the animals have to be such that they meet the nutritional requirements specified in terms of digestible crude protein (DCP) dry matter (DM) metabolizable energy (ME), calcium (Ca) and phosphorous (P) etcetra. Further, actual feeds and quantities to be fed will depend on their availability in the local market in different seasons and on their palatability. Prices of feed ingredients add another dimension to the ration formulation problem.

The major nutrient specifications for each productive class of bovine population are based on the milk production, body weight of the animal, fat content of the milk, and physiological status of the animal.

For preparing the linear programming model, the following type of information were considered:

1. Information on the level of milk production of dairy cow/buffalo in each type of farm
2. The average body weight of the animal
3. Average fat content of milk
4. The list of available feeds in the locality with their nutrient availability and corresponding prices
5. Specification of intake of digestible crude protein (DCP) metabolizable energy (ME), calcium (Ca), phosphorous (P) and dry matter (DM) in the ration
6. Specification of maximum voluntary intake of roughage.

4.17.1 Specification of the Model.

The cost minimization model used in this study can be briefly stated as:

Minimize

$$C = \sum_{o=1}^{n} P_o F_o \quad \ldots\ldots\ldots \quad (1) \qquad \text{viii}$$

Where,

C = Cost of feed materials

F_o = Quantity of 0^{th} feed material

P_o = price per unit of 0^{th} feed material

n = number of feed materials included in the plan

Subject to

$$\sum_{0=1}^{n} a_{10} F_o \geqslant N_1 \qquad \ldots\ldots\ldots (ix)$$

$$\sum_{0=1}^{n} a_{20} F_o \geqslant N_2 \qquad \ldots\ldots\ldots (x)$$

$$\sum_{0=1}^{n} a_{30} F_o \geqslant N_3 \qquad \ldots\ldots\ldots (xi)$$

$$\sum_{0=1}^{n} a_{40} F_o \geqslant N_4 \qquad \ldots\ldots\ldots (xii)$$

$$\sum_{0=1}^{n} a_{50} F_o \geqslant N_5 \qquad \ldots\ldots\ldots (xiii)$$

$$F_3 \leqslant 10 \qquad \ldots\ldots\ldots (xiv)$$

$$F_6 \leqslant 4.5 \qquad \ldots\ldots\ldots (xv)$$

and the non-negativity constraints

$$F_1 \geqslant 0 \qquad F_2 \geqslant 0 \qquad \ldots\ldots\ldots \; F_n \geqslant 0$$

Where

N_1 = Dry matter

N_2 = Digestible crude protein

N_3 = metabolizable energy

N_4 = calcium

N_5 = phosphorous

F_3 = Mulberry leaf stalk

F_6 = Maize khadbi

4.17.2 Feeds and fodder considered in the least-cost ration.

Though there were wide range of feeds and fodder fed to the bovine population, only major feeds and fodder available in the area and fed to animals were considered for developing the least-cost-feed plans.

4.18 DEVELOPMENT OF OPTIMAL PLANS

The following six types of optimum plans were formulated under Model I where risk in farm activities was assumed to be neutral.

Plan 1 - Existing technology - crop and dairy enterprise

Plan 2 - Existing technology - crop, dairy and sericulture enterprise

' technology - crop alone

Plan 4 - Improved technology - crop and dairy

Plan 5 - Improved technology - crop, dairy and vegetable crop

Plan 6 - Improved technology - crop, dairy, vegetable crop and sericulture enterprise.

4.19 MEASURES OF INSTABILITY IN FARM ECONOMY

Broader understanding of risk efficient optimum farm plans could be possible if only the nature and source of variability in gross margin are brought in for interpretation.

4.19.1 Instability in crop production.

Earlier studies concentrated on single factor to explain the instability in farm economy. Some of them were (1) variability in post-harvest prices (Kahlon, 1964); (2) variability in yield (Gupta, Vyas, 1964); (3) variability in rainfall (Malya, Patil, 1964); (4) variability in area and yield interaction (Hazell, 1982); (5) introduction of improved technology (Shakuntla Mehra, 1981).

In the present study, instability in farm economy was measured by working out coefficient of variation in each one of the factors, such as area, yield/ha., or yield/animal; prices of produce and the extent of correlation between area and yield; area and price; and yield and price and finally correlation between different types of farm enterprises. The formula used for working out coefficient of variation in the disturbing factors was -

$$CV = \frac{SD}{\bar{X}} 100 \qquad \ldots\ldots \quad (xvi)$$

$$SD = \sqrt{\frac{(X_i - \bar{X})^2}{n-1}} \qquad \ldots\ldots \quad (xvii)$$

Where,

CV = Coefficient of variation

SD = standard deviation

X_i = i^{th} observation in the time series data starting from 1969 to 1979

$\bar{x}$ = mean of the time series observations

n = number of years.

To depict the extent of fluctuation graphically for each enterprise variability index, taking mean of each item, namely yield per hectare, area under crop, price of produce, cost of production per hectare,[27] and gross return per hectare as 100, graphs were presented using ordinary least square method trend for gross margin per hectare was fitted. The trend equation was of the form:

$$Z_t = a + bt + e_t$$

Where,

Z_t = denotes dependent variable

t = time

e_t = random residual with zero mean and variance σ^2

4.19.2 Instability in dairy enterprise.

For dairy activities, a reliable time series information on milk production in the district was not available from any source. Therefore, estimation of milk production was attempted.

27/ Cost of production per hectare or per unit of activity was calculated by deflating current cost of production figure (1979) by corresponding price index number (Source: Agricultural Situation in India, Vol.32, No.6, page 189).

4.19.3 Estimation of milk production.

For the estimation of milk production number of milch animals were needed. The formula [28] for calculation of growth rate in milch animals is as followed

$$P_2 = P_1 \left(1 + \frac{r}{100}\right)^n$$

$$P_3 = P_2 \left(1 + \frac{r}{100}\right)^n$$

Where P_1, P_2 and P_3 were census details milch animal of 1966, 1972 and 1977 respectively for each taluka.

r = rate of growth

n = number of years between two consecutive census

A bifurcation was made in the number of cows so estimated from 1969 to 1979, as local cows and crossbred cows, based on the interim survey report of intensive cattle development project in Bangalore district. Thus number of local cows, crossbred cows and buffaloes formed the base for calculation of milk production.

Since sequential information regarding the productivity per milch animal was not available, results of the data pertaining to eight talukas covering 51 sample villages were taken for calculation of milk

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28/ Somasekara, N. (1978) Economic and Management of Public Utilities page 173. PTI Books Co., Bangalore.

production. Details about milk production of milch animals (talukawise) are given in appendix I Variance and standard error of the estimates of milk production for each type of milch animal (crossbred cow, local cow and buffalo) were calculated.29/

4.19.4 Gross margin per animal.

By attaching time series data of price of milk to the total milk production of the district from 1969 to 1979 gross income per cow or per buffalo was calculated. This in turn, was corrected to gross margin by deducting cost of milk production per animal from gross income.

Coefficient of variation for gross margin per animal and trend value for the gross margin per animal were calculated as mentioned before under crop activity (equation (xvi))

4.19.5 Cocoon production.

In the district cocoon production also constituted one of the major farm activities of the farmers. The total production of cocoons and the price per kg of cocoons net return per hectare of cocoon production were obtained from State Sericulture Department. The estimation procedure utilized the results of sample survey for

29/ Cochran, William G. (1977). Sampling Technique. Willy Eastern Ltd., New Delhi. page 95.

estimating the cost of production per hectare of cocoons and standard estimation[30/] for knowing yield of mulberry leaves from one hectare of irrigated land.

Coefficient of variation and trend values for gross margin/hectare of cocoons production were calculated as mentioned under crop activity. (equation xvi)

4.19.6 Inter-relationship between factors conducive to instability in farm economy.

The nature of instability was further analysed by assessing the interrelationship between the contributory or disturbing factors such as yield/ha., area under crop, prices, net return of other enterprise. Karl Pearson's correlation coefficient was worked out to bring out the crops or enterprise relationships in the district.

4.20 <u>RISK EFFICIENT FARM PLANS - MODEL II (MOTAD MODEL)</u>

The risk efficient production plans were developed by using MOTAD model as described below:

Minimize

$$Zo = \sum_{h=1}^{s} \bar{Y}_h$$

30/ Shyamala, M.B. (1979), 'Silk worm rearing'-Training on Modern Agricultural Technology for Agricultural Field Officers of Union Bank of India - University of Agricultural Sciences, Hebbal, Bangalore.

Subject to

$$\sum_{i=1}^{n} (C_{hi} - g_i) X_i + \sum_{k=1}^{12} (C_{hk} - g_k) D_k + \sum_{l=1}^{3} (C_{hl} - g_l) S_l + \bar{Y}_h \geqslant 0$$

for all h = (1 to 5)

$$\sum_{i=1}^{n} f_i X_i + \sum_{k=1}^{12} f_k D_k + \sum_{l=1}^{3} f_l S_l = \lambda$$

(λ takes the maximum feasible return) 31/

$$\sum_{i=1}^{n} \sum_{k=1}^{12} \sum_{l=1}^{3} a_{ij} X_i + a_{kj} D_k + a_{lj} S_l \leq b_j$$

$j = 1$ to m

$X_i, D_k, S_l, \bar{Y}_h \geqslant 0$ (for all i, k, l, h,)

Where

Z_a = Sum of the absolute values of the negative of the gross income of various enterprises from their trend values.

$\bar{Y}_h$ = Absolute values of the negative total gross income deviation in the h^{th} year from the trends (h = 1 to 11)

C_{hi} = Gross margin of the i^{th} crop in the h^{th} year

g_i = Trend value of the gross margin of the i^{th} crop activity

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31/ Hou, R.B. and P.B.R. Hazell (1968). Use of quadratic programming in farm Planning under uncertainty. Department of Agri. Economics. A.E. Research 250 Cornell University.

X_i = level of i^{th} crop activity

C_{hk} = Gross margin of k^{th} dairy activity in the h^{th} year

g_k = Trend value of the gross margin of the k^{th} dairy activity.

D_k = level of kth dairy activity

C_{hl} = gross margin of l^{th} sericulture activity in the h^{th} year

g_l = trend value of the gross margin of the l^{th} sericulture activity

S_l = level of l^{th} sericulture activity

f_i = gross margin coefficient of i^{th} crop activity

f_k = gross margin coefficient of k^{th} dairy activity

f_l = gross margin coefficient of l^{th} sericulture activity

= total gross margin

S = number of time series observation

n = number of activities

m = number of resource restriction

The variation in the total gross margin (λ) was examined by computing the coefficient of variation using the following formulae:

$$CV = \frac{SD}{\text{Gross margin}} \; 100$$

$$SD = \frac{2 \, Z_p}{S} \left(\frac{\pi \, S}{2(S-1)}\right)^{1/2} \quad \text{and}$$

Where

CV = Coefficient of variation of the gross margin

SD = Standard deviation from gross margin

Z_o = Value of the objective function

S = number of time series observation

TT = 22/7

4.21 OPTIMUM PLANS UNDER MODEL II

Risk efficient optimum farm plans were as follows:

Plan 7 Risk efficient farm plan for crop and dairy under existing technology.

Plan 8 Risk efficient farm plan for crop dairy and sericulture under existing technology

Plan 9 Risk efficient farm plan for crop alone under improved technology

Plan 10 Risk efficient farm plan for crop and dairy under improved technology

Plan 11 Risk efficient farm plan for crop, dairy, vegetable crop and sericulture activities under improved technology.

4.22 DATA ANALYSIS

Computer analysis was carried out with the help of computer Dec-10 at Indian Institute of Science, Bangalore.

CHAPTER - 5

CURRENT STATUS OF FARMING

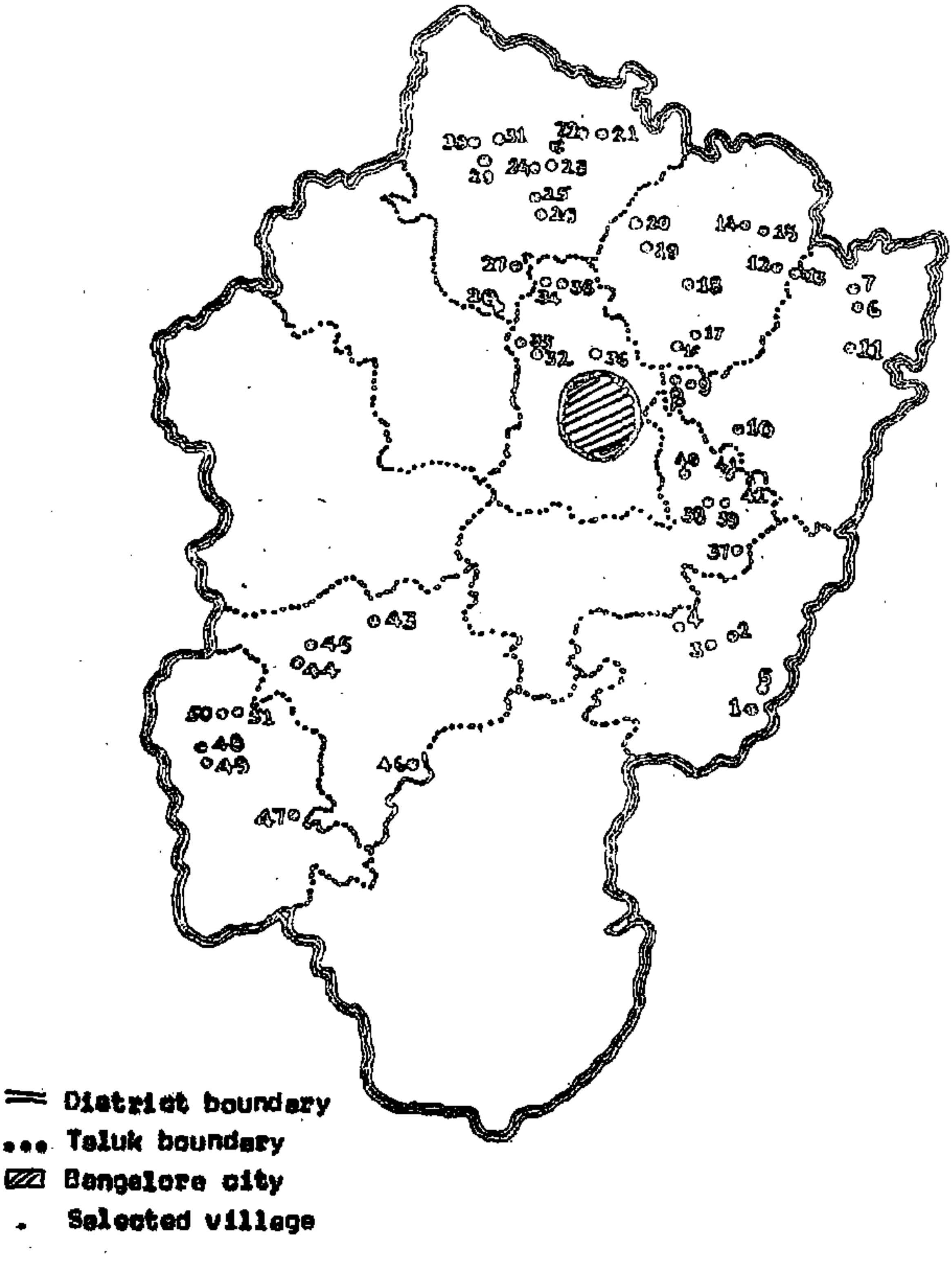
CURRENT STATUS OF FARMING

Since three decades rural area of Bangalore district has been undergoing radical changes due to various economic, sociological, political and institutional factors which have simultaneously interacted to exert considerable influence on the farmers' decision making process. Available information suggests that farmers' decisions vary due to the variation in the resource endowments. It has been observed that various constraints encountered by the farmers, normally stem from the differential endowment of farm resources which, inturn, dictate the pattern of investment in a particular enterprise. Therefore, the information on prevailing resource structure and investment pattern is needed to address policy issues, involving the provision of physical, financial and social stimulant to the farming community. Keeping this in view, an attempt has been made here to analyse some of the basic characteristics of the sample villages and farm households that may have a profound influence on production and marketing decisions and on profitability of farm production.

5.1 DESCRIPTION OF SAMPLE VILLAGES

The present study covers 51 villages of Bangalore district. The location of the villages

BANGALORE DISTRICT



selected are given in the map while the names of the selected villages are given in Appendix II.

Of the 51 villages, 20 are the headquarters of village panchayats. All the villages are connected with grain markets with a distance ranging from one kilometre to 34 kilometres. Further, 43 villages are directly under milk producer's cooperative societies for marketing of milk while only two villages have the centres of regulated market for cocoons.

The major sources of irrigation in the selected villages are tanks and wells. However, twelve villages have only tanks for irrigation purposes while eleven villages have only wells. The rest of the selected villages have both tanks and wells for irrigation. The major soil types in the selected villages are red sandy and black red mix soil.

In order to examine the occupational distribution of farm households, in the selected villages, data of all the households were analysed and are presented in Table 5.1.

It is evident from Table 5.1 that the main occupation for most of the farmers in the selected villages of the district was agriculture constituting about 62 per cent of the total households. Agricultural labour class ranked second which depended on wage earning as their primary occupation accounting for

Table 5.1: Occupational Distribution of Households in selected villages.

Sl. No.	Name of occupation	Number of households	Percentage to total households
1.	Agriculture	3831	61.99
2.	Business	157	2.55
3.	Dairying	148	2.39
4.	Service	340	5.50
5.	Artisan	96	1.55
6.	Agricultural labour	887	14.35
7.	Other occupation	721	11.67
	Total	6180	100

about 14 per cent of the total households. Interestingly, only about 2 per cent of the villagers took up dairying as their main occupation.

5.2 BOVINE POPULATION IN THE SELECTED VILLAGES

The structure of bovine stock in an area broadly indicates the preference of cattle keepers which, of course, is conditioned by ecological forces. Taking the study area as a whole, among total bovine stock, the proportion of Hallikar cows and buffaloes were generally higher than crossbred cows both for draught power and milk production. It was observed that on an average, the number of crossbred cows, Hallikar cows and buffaloes were 26, 67 and 60 per village respectively. Bullock power still plays an important part in the rural economy of Bangalore district where the number of bullocks per village ranged from 20 to 99, the average being 61.

5.3 SIZE OF FAMILY, LAND AND CATTLE HOLDINGS

The average size of family operational holding, irrigated area, cattle holding and availability of human labour on different categories of sample farms were worked out and are presented in Table 5.2.

It may be observed from Table 5.2 that the average size of family ranged from about 6 members on small farms to 12 members on large farms, the average being 7 members on the sample farms. Further, the average size of the operational holding on marginal, small, medium and large farms was 0.79 ha, 2.00 ha, 3.68 ha. and 7.75 ha. respectively, the overall size of holding being 2.98 hectares on the sample farms as compared to only 1.82 ha in the Bangalore district. Since the sample farmers were drawn for the present study with a specific background and purpose, the average size of land holding was observed to be above the district average.

Table 5.2 further reveals that out of total cultivated area on the sample farms about 28 per cent of the area was irrigated. Interestingly, the marginal farms registered the highest area under irrigation (42 per cent). This indicated that all the farm situations faced the dearth of irrigation facilities for crop production. It was observed that the marginal farms relied mostly on tank irrigation while all other farms mainly depended on well irrigation.

The structure and composition of bovine stock on the farms provide the baseline information about the status of dairying in the selected households. As against the composition of bovine population in the study area as a whole, the crossbred cows were observed to be the major milk producers in the sample households as evident from Table 5.2. The distribution of total adult bovine stock and its composition, however, vary among different categories of farms. The average number of milch animals ranged from about 3 on marginal farms to 7 on large farms, the overall average being 4 milch animals on the sample farms. The details of distribution of different breeds and species of dairy animals is given in Appendix III.

As regards the availability of human labour, it was observed that labour availability on the farms had positive relationship with farm size. The average number of family members available for work was about four on the sample households.

5.4 LITERACY STATUS

Level of education of the family members effect the economic decisions of the family.

The average literacy rate of the sample farm households was as high as 72 per cent as compared to about 38 per cent in the Karnataka state. This may perhaps be due to the fact that the area is well connected with the urban centre and most of the economic activities are meant to cater to the metropolis.

5.5 CROPPING PATTERN

The farmers generally try to diversify the farm production in order to insulate themselves from total crop failure caused by aberrations in weather or pest epidemics. However, the choice of crops grown was largely based on the home needs of the farmers and the availability of different resources. Table 5.3 presents the cropping pattern on different categories of farms.

Owing to the limited area for crop cultivation, marginal farmers mostly cultivated cereals and millets which were needed for their family consumption. It was observed that kharif ragi (local variety) on unirrigated land occupied major cultivated area on the marginal farms. Improved variety of ragi and horsegram during kharif season shared the unirrigated land to the extent of about 11 per cent and 3 per cent respectively. Maize, groundnut and potato cultivation had taken a very small proportion of cultivated land whereas fodder crops occupied a very negligible area accounting for only 1.07 per cent of the total cropped area.

Small farmers also cultivated ragi crop relatively on a larger area occupying about 65 per cent of the total cropped area. Irrigated land was kept mostly for paddy and maize cultivation which together accounted for about 17 per cent of the total cropped area. To a very small extent, fodder crops, sugarcane and horticultural crops like tomato, grape, potato and chilli were planted on irrigated land. However, mulberry crop occupied about 6 per cent of the total cropped area on the small farms.

The medium farmers allocated about 67, 14 and 2 per cent of the total cropped area for ragi, paddy

Table 5.31 Cropping pattern on the selected farm households (1979-80)

Sr. No.	Name of Crop	Category of Farms								Overall percentage
		Marginal		Small		Medium		Large		
		Area (ha)	Percentage to total cropped area	Area (ha)	Percentage to total cropped area	Area (ha)	Percentage to total cropped area	Area (ha)	Percentage to total cropped area	
1.	Ragi (local) unirrigated land (kharif)	0.378	43.46	0.57	32.04	1.271	39.85	2.860	31.73	36.80
2.	Ragi (improved) unirrigated land (kharif)	0.092	10.75	0.52	29.29	0.676	21.19	3.080	34.15	23.48
3.	" " irrigated land (kharif)	-	-	0.02	1.14	0.085	2.66	0.040	0.45	1.24
4.	Ragi improved irrigated land (rabi)	-	-	0.01	0.46	0.036	1.14	0.040	0.45	0.56
5.	" " " Summer	0.02	2.34	0.03	1.60	0.097	3.05	0.097	1.08	2.17
6.	Paddy (local) " kharif	-	-	0.07	4.12	0.182	5.71	0.130	1.44	3.32
7.	Paddy (improved) "	0.07	8.41	0.06	3.89	0.132	4.31	0.558	6.19	5.37
8.	Paddy " " Rabi	0.04	5.14	0.05	3.19	0.048	1.52	0.036	0.40	2.76
9.	Paddy " " summer	0.03	3.73	0.02	1.14	0.073	2.28	0.300	3.28	2.33
10.	Groundnut in unirrigated land (kharif)	0.01	0.93	-	-	0.012	0.38	0.093	1.03	0.45
11.	Groundnut in irrigated land (summer)	-	-	0.01	0.69	-	-	-	-	0.24
12.	Maize (kharif)	0.03	3.27	0.07	4.12	0.069	2.16	0.603	6.69	3.70
13.	Maize (rabi)	-	-	0.01	0.69	-	-	-	-	0.24
14.	Horsegram in unirrigated land (kharif)	0.03	3.27	0.03	1.84	0.045	1.40	0.115	1.27	1.95
15.	Jowar "	-	-	0.008	0.46	0.016	0.51	-	-	0.31
16.	Tomato irrigated (kharif)	-	-	0.008	0.46	-	-	-	-	0.16
17.	Chilli " (rabi)	-	-	0.008	0.46	0.020	0.63	0.040	0.45	0.41
18.	Potato "	0.004	0.47	0.008	0.46	-	-	0.215	2.38	0.58
19.	Grapes	-	-	0.016	0.92	0.03	0.89	0.166	1.85	0.83
20.	Sugarcane	-	-	0.028	1.50	0.081	2.53	0.224	2.48	1.57
21.	[illegible]	[illegible]	1.87	0.024	1.37	0.020	0.63	0.016	0.18	0.90
22.	Others	0.08	9.35	0.068	3.38	0.110	3.44	-	-	5.48
23.	Mulberry	[illegible]	7.21	0.109	6.18	0.182	5.72	0.405	4.49	5.19
	Total	0.87	100.00	1.77	100.00	3.19	100.00	9.02	100.00	100.00
	Cropping intensity	118		102.33		103.41		16.39		

and maize cultivation respectively. Almost negligible area was alloted to other food crops such as jowar and horsegram. Sugarcane and mulberry occupied about 3 and 6 per cent of the total cropped area respectively.

Large farmers also preferred cultivation of ragi as a major crop by devoting nearly 67 per cent of cropped area for it. Paddy and maize crops were cultivated on 11 and 7 per cent of the total cropped area respectively.

5.6 AREA, PRODUCTIVITY AND COST OF PRODUCTION OF FODDER CROPS

The availability of irrigated land for fodder production is a limiting factor for keeping high yielding cattle on most of the farms especially, in dry areas, where the intensity of its use in feeding the dairy herd and cost of fodder production are critical to success of the dairy enterprise. Therefore, it is essential to examine the area under fodders, their productivity and cost of production on different categories of sample farms. Table 5.4 shows the proportion of farmers of different categories growing fodders, their productivity and cost of production. It is clear from Table 5.4 that only about 8 per cent of the sample farmers grew green fodders on their land. It was observed that the average productivity of green fodder per hectare was about 81 qtls. and the average cost of

Table 5.4: Area, Productivity and cost of Production of fodders

Category of farms	Percentage of farmers growing fodders	Average cropped area allotted (hectare)	Productivity hectare (quintals)	Cost of production, ha. (Rs)	Cost/qtl.
Marginal farm	5.56	0.14	65.99	2043.00	30.95
Small farm	9.41	0.24	71.60	716.00	10.00
Medium farm	8.57	0.25	110.92	5335.00	48.98
Large farm	9.37	0.22	63.26	633.00	10.00
Overall	8.31	0.22	80.72	2346.00	29.06

production was Rs. 29.0/qtl. Among different categories of farms, medium farms had the highest productivity/ha. followed by small, marginal and large farms in that order. The cost of cultivating fodders was found to be the lowest on large and small farms and the highest on medium farms. The reason for variation in the cost figures could be attributed to the cultivation of different fodders like napier, gunlee grass and hybrid napier grown by different categories of farmers.

5.7 EXPENDITURE ON FEEDS AND FEEDING PRACTICES

The successful dairyman today should be much more cognizant of the feeding practices and value of various feeds fed to the milch animals than in the past because of the increasing intensity of cost-price squeeze. Feed cost makes up major portion of the total cost of milk production. This is the largest single area whereby income can be increased sufficiently by efficient utilization of various feeds.[32/] Therefore, it was considered appropriate to study the existing feeding pattern followed by the sample farmers and the expenditure incurred by them on various feeds fed which were assessed and are given in Table 5.5.

It may be observed from Table 5.5 that proportion of cost incurred on green fodder was only about

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32/ Richard C. Foley, Donald Bath, Frank N.Dickenson, H. Allen Tuccker (1972) Dairy Cattle: Principles, Practices, problems, profit. LEA and Febigh - Philadelphia. pp. 240

18 per cent where the mixed grass and napier constituted the major portion of green fodder. Dry fodder consisted of crop byproducts either available on the farms or purchased from the market. The principal dry fodder fed in the study area was ragi straw.

It was further observed that the concentrate mixture fed to the animals was mostly purchased from the market. The ratio by which various feed ingredients were mixed depended on many factors like the prices of feed ingredients, money at the disposal of the farmers and availability of feed. Due to these important reasons, it was observed that there was considerable fluctuation in feeding practices adopted by different categories of farmers. The details about the feeding practices in various months of the study period 1979-80 and the corresponding price/kg of home mixed concentrate mixture has been brought out in Appendix IV.

Table 5.5 further revealed that the major feed cost consisted of ragi straw followed by wheat & Rice bran and groundnut oil cake accounting for about 27, 20 and 13 per cent of the total feed cost respectively. However, large farmers mainly relied on compounded cattle feed. The proportion of expenditure on ragi straw was about 31 per cent while compounded feed and wheat & Rice bran accounted for about 18 and 16 per cent of the total cost respectively on the large farms.

Considering the feed expenditure per animal unit maintained by each category of farm, the total feed cost was found to be the highest on marginal farms and the lowest on small farms. The overall average feed cost per animal unit in the study area was about Rs. 777 per annum. The reason for highest feed cost on marginal farms can be attributed to lowest proportion of home grown roughages.

5.8 ECONOMIC AND NUTRITIONAL ASPECTS OF FEEDING PATTERN

It is well known that underfeeding of dairy animals results in low and inefficient milk production while over feeding becomes unprofitable because a large part of feed goes waste. Least cost ration which meets the minimum requirements of nutrients of the animal will reflect as to what extent the feeding pattern followed by the farmer deviates from the recommended level of ration.

Table 5.6 depicts the rations for various types of milch animals, growing and dry animals which were least costly for the farmers under the prevailing price structure and the same was compared with farmers' ration formula in terms of cost and the extent of saving he could have had by following least cost formula.

It may be observed from Table 5.6 that mulberry leaf stalk remnant formed the main source of green fodder

Table 5.6: Cost of feeding schedule recommended and existing level.

Per day per animal

Name of feed and fodder	Growing animal	Dry animal	Crossbred cow (milk yield 5 kg/day)	Crossbred cow (yield 6.5 kg/day)	Halliker cow(milk yield 2.5 kg/day)	Halliker cow(milk yield 4 kg/day)	Buffalo (milk 2 kg/day)	Buffalo (milk yie 3.5 kg/da
Mulberry, kg[1]	10.00	5.51	10.00	10.00	10.00	10.00	8.90	10.00
Maize Stover, kg[2]	3.43	3.69	5.84	6.12	3.98	5.04	4.44	4.94
Groundnut oilcake, gms	120	-	207	253	127	70	-	46
Cost at recommended leve, Rs.	1.42	0.89	1.84	1.95	1.49	1.53	1.26	1.48
Cost at existing leve, Rs.	1.72	1.78	2.82	3.82	2.62	1.53	1.65	1.69
Extent of saving by following recommended leve, 1) per day	0.30	0.89	0.98	1.87	1.13	-	0.36	0.21
2) per year	109.50	324.85	357.70	682.55	412.45	-	131.40	76.65

1. Mulberry leaf stalk ramnent after feeding the silk worms.
2. Maize stover (khadbis) chaffed.

which constituted 10 kgs per day per animal in the ration except for dry and low yielding buffalo. Maize stover (Khadbies) and groundnut cake varied for different types of animals which directly affected the cost of feeding.[33/] Further, it may be noted from the table that in practice farmers fed costly feeds to all types of animals. The extent of saving ranged from about Rs. 77 per year for buffalo to Rs. 683 per year for crossbred cow (yielding 6.5 kg/day). Interestingly, Hallikar cows (yielding 4 kg/day) received on an average a ration costing the same as the recommended least cost ration, though nutritive requirement was not met in the case of this group of milch animals.

The conventional system of feeding was also examined in terms of the nutritional requirement namely metabolizable energy (ME) digestible crude protein (DCP) and dry matter intake (DM). Table 5.7 presents the difference between the recommended and conventional feeding standard in terms of above nutrients in the feeds and fodder intake of the animal. It was observed from the Table 5.7 that in general, the animals were not getting required nutrients. The extent of deficiency in terms of dry matter was between 0.06 kgs per day in the case of dry animals and 2.46 kgs per day in the case

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33/ The details of the existing cost and the extent of decrease in the cost needed for non plan feeds and fodders (opportunity cost) are presented in Appendix V.

Table 5.7: Nutritional aspects of feeding practices - Adopted by farmers and advocated by animal nutritionist.

(Kgs per animal)

Type of animal	Level of Nutrient adopted by farmer			Level of Nutrient advocated			Difference		
	DM	DCP	ME	DM	DCP	ME	DM	DCP	ME
A. Growing animal	4.15	0.115	8.79	5.7	0.390	13.49	-1.55	-0.275	-4.7
B. Dry animal	4.64	0.160	9.78	4.7	0.203	11.04	-0.06	-0.043	-1.26
C. Milch animal									
1) Crossbred cow (5 kg/day)	8.67	0.550	19.25	7.94	0.451	15.38	0.73	0.099	3.87
2) Crossbred cow (6.5 kg/day)	7.88	0.380	16.54	8.24	0.473	15.95	-0.36	-0.093	0.59
3) Hallikar cow (2.5 kg/day)	3.92	0.070	8.59	6.20	0.318	8.67	-2.28	-0.248	-0.08
4) Hallikar cow (4 kg/day)	4.64	0.103	9.84	7.10	0.387	13.79	-2.46	-0.284	-3.95
5) Buffalo (2 kg/day)	5.00	0.190	10.14	6.23	0.317	12.07	-1.23	-0.127	-1.93
6) Buffalo (3.5 kg/day)	4.92	0.126	10.20	6.99	0.374	13.55	-2.07	-0.248	-3.35

of Halliker cows which was yielding 4 kgs of milk per day. However, crossbred cow (yielding 5 kg/day) received enough dry matter from feedstuff, digestible crude protein, a costly nutrient[34/] was also found deficient in the feeds fed to the animals which ranged from 43 gms per day per animal to 275 gms per day per growing animal. The fact that growing animals did not receive enough protein may be one of the reasons for delayed maturity. Except crossbred cows, all other types of animals did not receive the minimum energy requirement also (ME). The range in the deficiency was from 0.08 kg/animal (Halliker cow) to 4.7 kg per growing animal.

Further, it was observed that in general, marginal and small farmers fed their crossbred cows to the required nutritional level, though it costed more than the least cost ration. The other two farm situations, namely, medium and large farms, were feeding the animals below the requirements of DCP and ME. Balanced feeds that would cost least could offset many shortcomings in keeping profitable dairy animals. The farmers, therefore, should be exposed to the knowledge of nutritive value of the feeds and fodders and their importance for increasing milk production and for normal reproductive behaviour of the milch animals.

34/ The shadow price for this constraint in the least cost model showed Rs. 3/kg. If care is taken to meet the protein intake of the animal then the extent of expenditure also gets reduced. Details of shadow prices of nutrients are given in Appendix VI.

5.9 MORTALITY IN BOVINES

It is worthwhile to mention here that out of 51 selected villages of the district for the present study, only 8 villages were not having readily available veterinary aid. Table 5.8 provides the details of mortality in various categories of crossbred cattle and of buffaloes during the period of enquiry. Interestingly, no mortality was recorded in case of local cows. It is clear from Table 5.8 that about 14 per cent of crossbred youngstock and 6 per cent of buffalo youngstock died of various diseases. However, in case of adult animals, the proportion of deaths was comparatively high in crossbred cattle than buffaloes. In view of the heavy mortality among crossbred cattle, it may be suggested that ICDP functionaries and the farmers should follow adequate prophylactic measures regularly.

5.10 PRODUCTION TRAITS OF DAIRY ANIMALS

A study of production traits is an important aspect for the appraisal of efficiency of dairy animals. Success of dairy enterprise largely depends on production traits of the animals. There could be an endless list of exogeneous and endogeneous determinants of milk production system. But productivity of milch animals in the herd is dependent to a large extent upon the genetic make up and production potential of the individual animals. Individual animal's genetic worth is predicted in terms

Table 5.8: Incidence of mortality among bovines on the sample households.

Sl. No.	Type of animal	Adult	Young stock
1.	Crossbred cattle		
	Total number of animals	688	418
	No. of animal died	70	57
	Percentage mortality	10.17	13.63
2.	Buffalo		
	Total number of animals	412	213
	No. of animal died	9	12
	Percentage mortality	2.18	5.63

the performance levels of various physical traits such as age at first calving, service period, dry period, milk yield and body weight at various stages of growth.

Table 5.9 presents the important production traits of various species of animals maintained on the sample households which are discussed in the following sections.

5.10.1 Age at first calving.

The age at which the first calf is born to a cow/buffalo has great economic significance for dairy cattle keepers. Delayed maturity in cattle of buffaloes lengthens the pay back period of the investment in dairy enterprise.

It may be observed from Table 5.9 that the average age at first calving for crossbred cows was about 39 months as compared to about 54 months in Hallikar cows and 59 months for buffaloes. It was further noted that the age at first calving for crossbred cow was the lowest on medium farms amongst all other categories. However, this stands in contrast to the urban area of the district where the age at first calving of crossbred cows was observed to be only 30.7 months.35/

35/ Sharma, K.N.S. (1984) Economics of crossbred cattle in Bangalore. Ph.D. Thesis (unpublished), Kurukshetra University, Kurukshetra.

Table 5.9: Production traits of Milch Animals on the sample households.

Particulars	Marginal Farm			Small Farm			Medium Farm			Large Farm			Overall		
	Cross-bred cow	Halli-kar cow	Buffalo	Cross-bred cow	Halli-kar cow	Buffalo	Cross-bred cow	Halli-kar cow	Buffalo	Cross-bred cow	Halli-kar cow	Buff-alo	Cross-bred cow	Hall-ikar cow	Buff-alo
1. Age at first calving (months)	42.36	50.98	61.58	37.92	54.24	56.52	37.44	54.36	60.00	41.63	54.21	49.2	39.17	53.54	59.10
2. Lactation length (months)	10.13	10.60	10.50	9.60	9.40	9.17	9.7	8.97	9.43	9.54	7.59	7.62	9.76	9.50	9.94
3. Dry period (months)	3.29	4.00	4.00	3.55	5.67	6.00	2.95	6.50	4.50	3.04	9.50	6.00	3.20	6.62	5.42
4. Intercalving period (months)	13.42	14.60	14.50	13.25	15.07	15.17	12.65	15.47	13.93	12.58	16.19	13.92	12.96	16.12	15.36
5. Lactation yield (kgs)	1753	812	910	1536	1200	460	1075	709	632	2102	637	667	1919	843	621

Records of Hallikar cows showed that the age at first calving was minimum on marginal farms and maximum on large farms. The overall age at first calving was 53.54 months in the study area.

As regards the age at first calving for buffaloes, it was observed to be 59.10 months.36/ It was interesting to note that age at first calving for buffalo was only about 49 months on large farms. This could be attributed to better feeding and management of the animals on large farms.

5.10.2 Lactation yield, lactation length, dry and inter calving periods.

A cow/buffalo which calves regularly pays well ultimately. Regularity in calving necessitates optimum number of lactating and dry days which are normally specified as 305 and 60 days respectively. It was observed from Table 5.9 that the crossbred cows on marginal farms yielded on an average 1793 kgs of milk in 10.13 months. While on small farms, the yield was 1836 kgs in 9.6 months. Medium and large farms had better crossbred cows which yielded 1875 kgs of milk

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36/ Recordsof Southern Regional Station of N.D.R.I. indicated that H.F. crossbred cows calved for the first time at the age of 32 months and Jersey Tharparkar crossbred cows at the age of 35 months and buffaloes at the age of 45.13 months. But under field conditions where performance of animals are put to various constraints, the age at first calving is invariably high (Vijayalakshmi, S. and S.R.Sampath, 1982) 'Management Decisions and Implementation of programme for better performance of herd - A case study. Annual Jl. of Alumni Asso., NDRI, Bangalore 14, 12).

in 8.7 months and 2102 kgs of milk in 9.54 months respectively. However, the overall lactation yield for crossbred cows was 1919 kgs in 9.76 months.

The milk production per lactation in case of Hallikar cows ranged between 637 kgs of milk in 7.69 months on large farms to 1208 kgs in 9.4 months on small farms giving overall average lactation yield of 843 kgs in 9.5 months.

The overall lactation yield of buffaloes in the study area, was 621 kgs of milk in 9.94 months which varied between 460 kgs on small farms and 910 kg on marginal farms.

As a healthy practice, dry period of milch animal is to be maintained for about 60 days. But under rural conditions due to delay in successful insemination or for other reasons, the dry period is much more than the desired norm. With the dry period increasing the animal remains unproductive which would put the farmers in a clear disadvantageous position. The average dry period for crossbred cows, Hallikar cows and buffaloes was 3.2, 6.6 and 5.4 months respectively.

The regularity in calving followed by optimum lactation length and dry period could not be maintained in the study area due to many reasons. As a result, the intercalving period was prolonged. The average intercalving period recorded for crossbred cows, Hallikar cows and buffaloes was about 13 months, 16 months and 15 months respectively.

5.11 SIZE OF THE ANIMAL

The body weight of the animals is considered as one of the important factors which affect the lactation yield. The sample animals which were kept for study during 1979-80 were measured (girth measurement) with an inch tape which correspondingly contains the weight. According to that the crossbred cows weighed between 316 kgs and 388 kgs the average being 340 kgs. Hallikar cows weighed between 265 to 277 kgs and the average weight marked out to be around 270 kgs and buffaloes' average weight was 320 kgs.

5.12 ARTIFICIAL INSEMINATION AND HEALTH COVER FOR ANIMALS

Timely successful insemination service to milch animals is one of the major factors that affects the profitability of dairy farming in India. Though a net work of extension agencies are involved to render timely service, the different management practices adopted by the farmers after calving also affect the intercalving period.

By and large, it can be stated that delay in successful insemination leads to unprofitable maintenance of milch animals in rural areas. The recorded data speak that animals received successful insemination only after three or four services. As a result 90 to 120 days were taken to get the animal inseminated successfully.

For successful animal keeping, adequate prophylactic measures are equally important along with other genetic and nutritional aspects. Failure to take preventive and curative measures against contagious diseases was observed to be frequent among the farming community due to various reasons. Details about proportion of farmers who had taken preventive and curative measures are given in Appendix VII.

5.13 LABOUR DISTRIBUTION FOR VARIOUS DAIRY OPERATIONS

Dairy farming, operated on scientific lines, increases not only income but also the employment potential in rural areas. It was observed that in the sample household on an average, 16 per cent of the total employment days on the farm was utilized by dairy enterprise. Detailed information about the pattern of employment, the division of labour and extent of participation of male and female members of farm households in various operations of milk production would enlighten the extent of utilization of rural labour force. The data pertaining to labour employment were analysed and are presented in Table 5.10.

It is evident from Table 5.10 that the average human labour use ranged from 265 mandays on marginal farms to 736 mandays on large farms during the year, the average being 466 mandays. The human labour use was the highest in grazing operation followed by

Table 5.10: Utilization of human labour for various dairy operations.

(in man days)

Category of farms	Total mandays employed for dairy operation	Labour employed for					
		Taking the animal for grazing	Bringing fodder	Feeding	Cleaning	Milking	Sale of milk
Marginal farm	265	109	57	31	39	15	13
Small farm	371	158	75	45	51	21	20
Medium farm	493	191	103	65	75	38	26
Large farm	736	194	174	122	139	68	39
Overall	466	163	102	66	76	36	25

bringing fodder from the farms. The least time consuming operations were milking and selling of milk.

It was further observed that in general, adult male members of the family brought fodders and took the animals for grazing. However, adult female members shouldered all other responsibilities of maintaining the dairy animal. Feeding - one of the most crucial operation in dairy enterprise was to a great extent allotted to the child labour on all the category of farms. The wastage of feeds or fodders or deficit in feeding standard as brought out in earlier section could be partly attributed to the reliance on child labour for feeding the animal.

5.14 PRODUCTION, CONSUMPTION AND MARKETED SURPLUS OF MILK

Milk being a perishable commodity presupposes a ready market. The proportion of milk marketed by the farmers ascertain the extent of commercialization in this enterprise. In order to examine the mode of utilization of milk by various categories of farmers, data were collected on production, consumption and marketed surplus of milk. Marketed surplus of milk was further studied for the disposal pattern. The detailed information on the above parameters was worked out and is presented in Table 5.11.

It may be observed from Table 5.11 that production, consumption and marketed surplus of milk were positively related to size of farm. The overall average

Table 5.11: Production, consumption and marketed surplus of milk (1979-80)

(Quantities in kgs)

Category of farm	Total production	Total consumption	Disposal milk producers Co-operative society	Through middle-man	Private dairy	Consumers directly	Others	Total qnty. marketed
Marginal farm	992	321	501.58 (74.75)	147.62 (22.00)	6.64 (0.99)	15.16 (2.26)	-	671 (100)
Small farm	1623	415	826.87 (68.45)	294.75 (24.4)	31.9 (2.64)	35.76 (2.96)	18.72 (1.55)	1208 (100)
Medium farm	2332	561	1473.83 (83.22)	184.18 (10.40)	36.66 (2.07)	64.11 (3.62)	12.22 (0.69)	1771 (100)
Large farm	5116	820	3813.4 (88.77)	447.21 (10.41)	7.30 (0.17)	9.62 (2.24)	18.47 (0.43)	4296 (100)
Overall	2156	491	1341.93 (80.59)	250.34 (15.03)	24.43 (1.48)	35.99 (2.16)	12.31 (0.74)	1666 (100)

Figures in parenthesis indicate percentage to total quantities marketed.

milk produced was 2156 kgs per household per annum which ranged from 992 kgs on marginal farms to 5116 kgs on large farms. It was observed that the marginal farms retained 321 kgs of milk for family consumption while large farmers retained 820 kgs for home consumption. The overall quantity of milk kept for consumption was worked out to be 491 kgs.

It was noted that a sizable quantity of milk was marketed through milk producers' cooperative Societies The proportion of marketed surplus sold through milk producers' cooperative societies ranged from 68 per cent on small farms to 89 per cent on large farms, the average being about 81 per cent. The middle man shared about 15 per cent of the total marketed surplus. Other agencies like private dairy, hotels or direct sale to consumers constituted a negligible proportion of marketed surplus of milk.

5.15 CATTLE MARKETING

The organised marketing of bovines in the Bangalore districts is conspicuous by its absence. However, cattle marketing is an important source of income to the cattle keepers who sell their animals through unorganised marketing agencies. It was observed that during the study period, about 33 per cent of the total animals were sold out for various reasons such as need of money, attractive price offered, problem animals, and costly maintenance.

The income received by selling the animals partly depends on the bargaining power of the seller. Table 5.12 shows the average selling price of different types of milch animals. It is clear from the table that large farmers had better bargaining power than marginal and small farmers. Thus, a crossbred cow could fetch Rs. 3300 to large farmers while marginal farmer could get only Rs. 2682. Similar situation existed in case of Hallikar and buffalo milch animals.

5.16 INVESTMENT PATTERN

The farm assets structure plays a vital role in streamlining the productivity of crops and dairy enterprise. The pattern and magnitude of investment on fixed assets in dairy enterprise are important indicators of the income generating capacity of the cattle keepers. Therefore, investment made in various farm assets on different categories of farms was assessed and is brought out in Table 5.13.

An examination of Table 5.13 indicates that on an average the farmers made the highest investment in dairy animals accounting for about 46 per cent of the total investment. Next in importance were the irrigation structure and cattle-shed sharing about 17 and 16 per cent of the total investment. Other farm assets like farm building, bullock drawn implements, hand tools and dairy equipment, together accounted for about 21 per cent of the total investment.

Table 5.12: Average selling price of milch animals on sample households.

Type of farm	Price of			
	Crossbred cow	Hallikar cow	Buffalo	Working stock
	Rs	Rs	Rs	Rs
Marginal	2978	606	860	1300
Small	2682	655	619	865
Medium	3093	459	618	800
Large	3300	1871	1183	1137
Overall	3013	898	820	1026

Table 5.13: Investment on crop and dairy farm assets

(Rupees per household)

Particulars	Category of Farm				
	Marginal	Small	Medium	Large	Overall
A. Investment on crop production					
1. Irrigating pumpsets	2500 (25.12)	3100 (20.72)	2250 (11.56)	5200 (15.33)	3000 (16.99)
2. Farm building	700 (7.03)	735 (4.91)	980 (5.04)	3358 (9.91)	1148 (6.49)
3. Bullock cart	-	1100 (7.35)	1200 (6.17)	2080 (6.19)	1013 (5.75)
4. Bullock drawn implement	208 (2.09)	227 (1.52)	325 (1.67)	880 (2.60)	338 (1.90)
5. Bullocks (pani)	-	-	1500 (7.71)	2500 (7.37)	770 (4.34)
6. Hand tools	78 (0.78)	62 (0.41)	225 (1.16)	545 (1.61)	133 (1.00)
Sub Total	3486	5224	6480	14563	6450
B. Investment on Dairy enterprise					
1. Dairy animal	5337 (53.62)	7385 (49.36)	8950 (46.00)	13400 (39.53)	8191 (46.30)
2. Cattle shed	1021 (10.25)	2229 (14.90)	3856 (19.82)	5682 (16.76)	2897 (16.38)
3. Dairy equipment	110 (1.11)	122 (0.83)	170 (0.87)	254 (0.75)	151 (0.85)
Sub Total	6468	9736	12976	19336	11239
Total investment	9954 (100)	14960 (100)	19456 (100)	33899 (100)	17689 (100)
Investment per milch animal	1847	2712	3370	3132	2789

(Figures in parenthesis indicate percentage to total investment)

Categorywise analysis of investment pattern reveals that there was a sizeable variation in the total investment in dairy assets per household made on different categories of farms. It was noted that investment varied between Rs. 6468 on marginal farms and Rs. 19336 on large farms, the average being Rs. 11239. Taking investment per milch animal into consideration, medium farms made the maximum investment amongst all farms. However, the absolute difference in the money invested per milch animal between medium and large farms was not much. Further, investment on pump sets was the highest on large farms followed by small, marginal and medium farms, in that order.

In general, the major extent of investment on dairy enterprise bear testimony to the fact that farmers in the study area have realized that dairying is a lucrative enterprise.

5.17 COCOON PRODUCTION

Apart from giving income and employment to the surplus labour force in the rural areas of dry zone,[37/] cocoon production adds to the feed availability for livestock either by left over mulberry leaf stalks or

37/ According to a world bank survey, one hectare of rainfed land under mulberry will give a net income of Rs. 3000 excluding the labour component. Please see : (Meenakshi Sundram, S.S. (1983); "Sericulture as a subsidary enterprise in dry land development." Seminar cum workshop in dry land development, G.K.V.K., Bengalore.

silk work pepas.[38] Due to the multipurpose use of mulberry cultivation which is linked up with quality and quantity production of cocoons, silk worm rearing is getting popular among farmers of the Bangalore district.

Of the total 240 sample farmers, 90 farmers reared silk worms regularly. Three varieties were reared in the area. viz., (i) local variety which is considered as traditional, (ii) medium variety and (iii) large or bivoltin variety. Though this enterprise has been invogue for more than 10 years, the situation was not satisfactory as compared to that of experimental farms.[39] In order to evaluate the economics of cocoon production in the sample household, data were analysed and are presented in Table 5.14.

It is clear from the table that the overall cocoon production on the sample households needed on an average per household investment of Rs. 7042 and 1422

38/ Sampath, S.R. (1983). Rearing dairy animals in dry land areas of Karnataka - A subsidary occupation for rural community. Seminar-cum-workshop on dry land development, G.K.V.K., Bangalore.

39/ Economics of bivotine cocoon production from one hectare of mulberry

1. Leaf yield		30000 kg
2. Total number of		4000 kg
3. Cocoon yield		1200 kg
4. Total realization from cocoons, Rs. 25/per kg	Rs.30000	
5. Expenditure - rearing cost Rs. 2150/500 dfl		Rs. 17,200
6. Net income (4-5)		Rs. 12,800

Source: Shyamala, M.B. (1979) 'Silk work rearing' Lecture notes. Staff training unit, Directorate of Extension, University of Agril.Sciences, Bangalore.

Table 5.14: Economics of cocoon production - varietywise.

(Rupees per household)

Particulars	Fixed cost		Labour (mandays)	Variable cost				Total income	Return over fixed cost(exclu-ding family labour)
	Building	Equipment		Value of eggs	Cost of leaves	Other charges	Total cost		
Local variety	6750	1179	254.8	144	419	212	775	1739	964
Medium variety	7655	1717	856.6	828	7808	506	9142	10535	1393
Large or Bivoltin variety	7210	1413	401.8	394	1053	494	1941	8104	6163
Overall	7042	1422	488.2	468	2620	459	3547	7933	4386

on building and equipment respectively. The average return over fixed cost (excluding labour component) worked out to Rs. 4387 per annum. Bivothin - an improved variety yielded the highest return over the fixed cost which amounted to Rs. 6163 per household per year. The lowest return over fixed cost was observed in the case of local variety which fetched only Rs. 964 per household per year.

5.18 NET RETURN FROM VARIOUS FARM ACTIVITIES

A diversified income is usually desired in dry land farming. Receiving an income from several sources rather than one is at least a partial insurance against unfavourable price changes or unforeseen yield risk. The proportion of net income derived from an enterprise pictures the relative importance of the particular enterprise on the farm. An attempt was, therefore, made to furnish the detailed information about net income per farm from various farm activities.

Table 5.15 provides details of income received and expenditure incurred for various enterprises on various categories of farms. The table adds in pointing out the strong and weak enterprises in the farm business in terms of profit.

It was observed that on an average, the sample farm households had spent maximum on crop cultivation followed by dairy and sericulture enterprises.

Table 5.15: Yearly income and expenditure of various farm activities in the sample household (1979-80).

(Rupees per household)

Particulars	Category of farm				
	Marginal	Small	Medium	Large	Overall
1. Expenditure					
a. Crop enterprise	3942	3799	7870	15027	6515
b. Dairy enterprise	4542	4046	4479	7610	4757
c. Sericulture enterprise	1640	600	500	8248	1820
Total expenditure	10124	8445	12849	30885	13092
2. Income					
a. Crop enterprise	2216	3618	7160	21255	6693
b. Dairy enterprise*	4734	5748	8194	11337	6983
c. Sericulture enterprise	1224	3759	3003	6195	3303
Total income	8174	13125	18257	38787	16979
Net income	-1950	4582	5408	7902	3887

* It includes income from sale of animals and sale of milk.

A total expenditure of Rs. 6515 was spent on crop production compared to Rs. 4757 and Rs. 1820 on dairy and sericulture enterprises respectively. However, it is significant that the expenditure pattern of marginal and small farmers exhibited a different trend placing dairy enterprise on top priority as against the overall expenditure pattern. On the other hand, the overall income per household states that the proportion of income derived from dairy through sale of milk and cattle, was maximum compared to crop and sericulture. Thus, total income derived from dairy enterprise was Rs. 6983 as compared to Rs. 6693 and 3303, from crop and sericulture respectively. Interestingly, the strong point in the farm business was noticed in the case of dairy enterprise which brought a positive net return on all the categories of farms whereas the crop production showed a negative net return on all categories of farms. Sericulture in small and medium farm situation brought a positive return, whereas on marginal and large farms it gave a negative return. The overall balance sheet showed a positive net return of Rs. 3887 from these three major farm activities on selected sample households. However, marginal farms showed a loss to the extent of Rs. 1950/year. In general, it may be pointed out that cocoon production and milk production including cattle marketing had an important role in generating income and adjusting the losses from crop production.

In the succeeding chapters, the existing return over fixed farm resources are improved by optimum plans which have assured increased and stable income.

CHAPTER - 6

MODEL-I RISK NEUTRAL OPTIMUM FARM PLANS

MODEL - I - RISK NEUTRAL OPTIMUM FARM PLANS

The assumption behind Model I is that farmers' objective is to maximize aggregate net returns which are considered stable, subject to price and non price constraints. By this qualification, under Model I, six plan alternatives for each synthetic farm situation comprising two levels of technology were brought out. In this chapter each optimum plan is discussed in terms of gross margin, utilization of resources, and level at which the non plan activities would start to compete with optimum plan activities (opportunity cost). Shadow prices of constrained resources/restriction were brought out separately wherein a comparison of pricing under the six plans were indicated.

6.1 MARGINAL SYNTHETIC FARM

Marginal farms are, in view of the stringent land resources, called as family farms. Land is used for growing millets and cereals, primarily for home consumption and occasionally for market. It is contended that marginal farmers have poor resource base, especially, land and capital. And, for over one and a half decades, government agencies, like marginal farmers and agricultural labour agency (MFAL) have been making ceaseless efforts to insist the marginal farmers to shift to new technology with some arbitrary credit supply. The technology, in crop and in dairy production provide important know-how to circumvent the problem of seasonal and perishable nature of agricultural and dairy produce and institutional finance synchronises the process of development for this farm situation. In this technology-credit syndrome how best the marginal farmers can utilize their resources is brought out in the following plans which consider two levels of technology and six alternative choices for production processes to choose from.

6.1.1 Optimum plans under existing technology Plan 1 and 2.

Constraints and problem matrix for marginal farm situation are presented in Appendix VIII. Plan 1 and 2 represent optimum plan under existing technology wherein the former considered crop and dairy and the latter, crop dairy and sericulture. Inspite of the flexibility in the constraints, plan 1 and 2 have shown the same profit levels with same level of activities. Hence they are discussed under a single heading.
Table 6.1 presents activities in the plan both real and disposal. The following are the crop and dairy activities in the plan.

6.1.1.1 Crop Activities:

Optimum plan could utilize 0.42 hectare of unirrigated land in kharif season and 0.247 hectare of

Table 6.1: OPTIMUM FARM PLAN 1 and 2
Marginal Synthetic Farm

Activities in the plan	Unit of activities	Level of activities
REAL ACTIVITIES		
Crossbred cow, dry	Number	2
Hallikar cow milking, type 1	"	1
Cow milk sale, kharif	Kgs	40
Cow milk sale, rabi	"	113
Ragi improved unirrigated land, kharif	ha	0.42
Ragi improved, summer	ha	0.247
Paddy, kharif	"	0.170
Paddy, rabi	"	0.322
Maize, kharif	"	0.152
Napier	"	0.00046
Bullock hire period 3	pair days	9.35
Bullock hire period 5	"	3.35
Capital borrowing, kharif	(Rs 100 s)	66.70
Capital borrowing, rabi	"	1.24
Capital borrowing, summer	"	10.10
Ragi sale, kharif	Qtls	3.25
Paddy sale, kharif	"	3.43
Paddy sale, rabi	"	8.37
Purchase of milk	Kgs	8.00
Purchase of paddy, summer	Qtls	2.90
DISPOSAL ACTIVITIES		
Land irrigated, summer	Ha	0.0743
Labour period 1	Mandays	50.890
" " 2	"	163.430
" " 3	"	51.185
" " 4	"	184.020
" " 5	"	62.320
" " 6	"	213.770
Bullock labour 2	Pair days	5.204
" " 4	"	12.590
" " 6	"	10.030
Ragi straw	Qtls	8.860
Paddy straw	"	6.365
Maize khadbi	"	0.975

irrigated land in summer for the production of improved variety of ragi both for home consumption as well as for market sale. Total production of ragi was 9.25 quintals, out of which six quintals were kept for home and remaining 3.25 quintals were shown as sold at existing prices. The input-output coefficient for paddy for this category of farms was congenial to bring about surplus produce for the market. The area under improved variety of paddy in kharif and rabi seasons was 0.17 hectare and 0.322 hectare of irrigated land respectively, which, after meeting home requirements, generated marketed surplus of 3.43 quintals and 8.37 quintals in the respective seasons. However, 2.9 quintals in summer season was shown as bought in the plan since there was no summer paddy crop. This was due to the existence of summer ragi in the plan and also due to the buying activities, which were introduced in the matrix to relax the minimum requirement constraints of paddy. Maize fulfilled minimum home requirement by its area allotted in this plan, namely 0.152 hectare of irrigated land. Napier grass had occupied a very negligible area which amounts only to 0.00846 hectare. This may be perhaps due to the constraint introduced in the problem matrix, otherwise it might not have entered the plan.

6.1.1.2 Dairy Activity:

To have flexible farm plan, dairy animals were considered for dual purpose in the problem matrix, namely, milk production and cattle marketing which exactly is the present situation in Bangalore district. Two dry crossbred cows kept for marketing had entered the optimal plan for adding profit in the objective function to the extent of Rs. 6500. One local Hallikar cow kept only for milk production had the advantage of supplying milk to the household. While there was surplus milk for sale during the kharif and rabi seasons the farmers had to meet their domestic requirements in summer by purchasing milk according to the plan prices (Rs. 2.50/kg) higher than they received (Rs. 1.60/kg) for their product.

6.1.1.3 Additional Resources - Hired/Borrowed:

To execute the optimal plan additional bullock power was required for which capital was utilized at the existing market rate. It was of the order of 9.35 days in kharif peak season and 3.54 days in rabi peak season. Since the capital borrowing activity was included in the matrix as unconstrained and since the maximum amount the plan could borrow was assumed to be limited only by the resources at the disposal of the farm, the plan showed a total of Rs. 7805 as borrowed for all the three seasons.

6.1.1.4 Disposal Activities in the Plan:

Unutilised resources or produce were also notified from the final iteration of the optimum solution Table 6.1 also shows the extent of unutilised resources in the optimum plan. There was 0.0743 hectare of summer irrigated land shown as unutilised. This can perhaps be utilised if cocoon production activities enter the plan 2 in which sericulture was combined with dairy and crop activities. Similarly, the farm labour unemployed in the six periods could be employed again if cocoon production activities enter the plan and maize production is increased so as to bring income from market sale. Other unutilized resources include bullock period during drough seasons and ragi straw, paddy straw and maize khadbi. These dry fodder could be utilised if crossbred heifers, Hallikar and buffalo and dry Hallikar cow would enter the plan.

6.1.1.5 Opportunity Cost of non plan activities:

Table 6.2 depicts the existing profit level and the competitive profit needed by the non plan activities. Ragi (local) activity on unirrigated land during Kharif season and improved variety - Indaf- 5 along with jowar would start competing with plan activities only if the profit would have been Rs. 1264 and 857 respectively. Paddy crop during summer would be possible if the crop could bring a net profit of Rs. 2111/ha instead of Rs. 1938/ha.

Cow and buffalo activities which were considered in the matrix and which did not enter the plan could compete with optimum plan activities only at a higher profit level. Thus crossbred cow, kept for milk production and cattle marketing should have had Rs. 74.8 more than the present level of profit, and while crossbred heifers needed Rs. 703 more, local Hallikar cow -dual purpose of milk and cattle

Table 6.2: Opportunity cost of non-plan activities under existing technology of Marginal farm condition.

Name of non-plan activity	Existing price/ profit level, Rs	Profit/price at which activity compete the optimum plan, Rs.
Crossbred cow, type 2	1025	1100
Crossbred, heifer	1100	1803
Hallikar cow, type 2	302	1432
Hallikar cow, dry	360	2287
Halliker, heifer	432	1758
Buffalo, type 1	438	552
Buffalo, dry	200	2885
Buffalo, heifer	360	3487
Selling price of cow milk/kg Summer	1.60	2.62
Ragi (local) in unirrigated land, kharif	838	1264
Ragi (local) with jowar and Avare in unirrigated land, kharif	405	417
Paddy, summer	1938	2111
Cucumber, summer	363	3914
Tomato, rabi	2429	4005
Carrot, rabi	2415	2917
Sale of paddy, summer	112	127.68
Sale of maize, kharif	129	256
Cocoon, small	4090	9324
Cocoon, medium	1537	9498
Cocoon, large	4820	9562
Ragi straw buying	40	11.2

marketing-needed Rs..1020 more; dry Hallikar cow needed Rs. 1130 more, heifer of this breed must have brought Rs. 1927 more than the existing level. Buffaloes were short of Rs. 1326, 1137, 2685 and 3127 respectively for type 1 (milk production only), type 2 (dual purpose), dry buffalo and heifer. Other crop activities proved to be comparatively less effective in bringing returns to the marginal farm. They could be considered for optimum plan only if, for example, beans could generate profit of Rs. 3914/ha. instead of Rs. 363/ha. tomato Rs. 4006/ha instead of Rs. 2429 and carrot Rs. 2917 instead of Rs. 2915.

Silk worm rearing and cocoon production needed much more profit to compete with food crop activities. Thus local or small variety of cocoon needed Rs. 5233/ha more, medium variety needed Rs. 7960/ha more and improved or Bivoltin variety needed Rs. 4744/ha more than the existing net profit.

The above information about non plan activities are highlighted here to provide additional guidelines to the developmental programmes which were introduced in the district of Bangalore and other parts of the state namely, loan facilities to marginal farmers to encourage silm worm rearing or keeping crossbred cow or cultivation of horticulture crops. Success in this direction could be possible only if the existing profit level be improved as shown by the opportunity cost.

6.1.1.6 Improvement of Plan 1 and 2 over existing condition:

Table 6.3 brings the improvement of Plan 1 and 2 over existing condition. Under existing condition marginal farmer even with cattle marketing incurred a loss of Rs. 1950. But under plan 1 and 2 the net return rose upto Rs. 8124 and even after deducting the amount of Rs. 6500 which were from sale of animal, the plans had positive return of Rs. 1624. Land was utilized under existing condition to the extent of 118 per cent by farmers. But under optimum plans 1 and 2, there was a possibility of utilizing the land to the extent of 144.08 per cent. The improvement over present condition was thus 22.10 per cent. However, human and bullock labour was not utilized as in the existing practice. There was unemployment of labour to the extent of 87 per cent of man days available in the farm under optimum condition as against 46.25 per cent in practice.

6.1.2 Plan 3 - Improved Crop Technology.

Plan 3 was developed for improved crop production taking food grains, ragi, paddy, maize and horsegram, and commercial crops, groundnut and sugarcane. The following are the activities in the plan (Table 6.4).

6.1.2.1 Crop Activities:

Improved variety of ragi crop cultivated along with jowar crop on unirrigated land during kharif season

Table 6.3: Existing condition and optimum plans (Model I) in terms of utilization of resources and net income.

Marginal Synthetic Farm

Name of resource	Existing condition	Optimum Plans					
		1	2	3	4	5	6
A. Land							
i) Total cropped area, ha	0.93	1.34	1.34	1.45	1.56	1.55	1.82
ii) Cropping intensity	118	144.08	144.08	155.91	167.74	166.67	195.7
Improvement over existing, percentage		22.10	22.10	32.13	42.15	41.25	65.85
B. Labour utilization, mandays	493 (53.75)	125 (13.63)	125 (13.63)	179 (19.55)	125 (13.63)	227 (24.80)	850 (92.3)
C. Bullock labour utilization, pair days	57 (118.27)	20 (42.04)	20 (42.04)	27 (56.56)	23 (48.67)	24 (51.04)	17 (35.20)
D. Capital mobilized, Rs.	10124	4749	4749	4000	4082	4832	3883
E. Net income generated Rs	-1958	8124	8124	3299	2778	3045	4138
Proportion of net income from cattle marketing	-	80	80	-	-	-	-

Figures in parenthesis indicate percentage to total.

Table 6.4: OPTIMUM FARM PLAN 3
Marginal synthetic farm

Activities in the plan	Unit of activities	Level of activities
REAL ACTIVITIES		
Ragi unirrigated, kharif	hectare	0.460
Ragi, rabi	"	0.198
Ragi, summer	"	0.223
Paddy, kharif	"	0.107
Paddy, rabi	"	0.107
Paddy, summer	"	0.107
Maize, kharif	"	0.223
Maize, rabi	"	0.0247
Ragi sale, kharif	Qtls	9.82
Maize sale, kharif	"	12.00
Bullock hire period 1	Pair days	8.09
Bullock hire period 3	"	3.30
Bullock hire period 5	"	3.85
Capital borrowing, kharif	Rs. 100 s	47.60
" " , rabi	"	7.54
" " , summer	"	7.75
DISPOSAL ACTIVITIES		
Labour period 1	Man days	59.53
" " 2	"	190.60
" " 3	"	65.27
" " 4	"	212.03
" " 5	"	67.05
" " 6	"	209.41
Bullock period 2 labour	Pair days	1.58
" " 4	"	9.18
" " 6	"	10.09
Ragi, rabi	Qtls	4.66
Ragi, summer	"	5.49

utilized all the land available for cultivation, that is 0.46 ha. During rabi and summer 0.198 hectare and 0.223 ha of irrigated land was kept for producing improved ragi. In all, a total of 25.94 quintals was produced. But after meeting home requirement 6 quintals only 8.09 quintals were sold. The remaining 4.66 quintals rabi and 5.49 quintals of summer ragi were shown as surplus kept in disposal activity in the plan for want of remunerative price. The price at which they could be sold as shown by opportunity cost is Rs. 184.14/qtls (Table 6.5) which is almost double the existing price. The next competing crop was ragi on unirrigated land. It could enter if there would be a slight increase of Rs. 2.41/ha in profit. Paddy even with improved technology could not enter market sale, so a minimum of 0.107 ha in each season was set aside for meeting home requirements. Perhaps, if there could be increase in price of paddy sale then there could be chances of having more area for paddy. Maize could bring a surplus production during kharif season from 0.223 ha of land. Twelve quintals were sold after meeting home requirement of 1.5 quintals. Rabi maize could satisfy only domestic demand by its 0.0247 ha.

6.1.2.2 Additional Resources:

This plan hired bullock labour in all the seasons with 8.09, 3.3 and 3.85 days in kharif, rabi and summer peak seasons respectively. The capital borrowings during the respective seasons were Rs. 4768, 754 and 775.

Table 6.5: Opportunity cost of non-plan activities at improved technology - Marginal farm.

Name of non-plan activity	Profit/price considered in the plan Rs	Price/profit at which activity compete the optimum plan activ Plan 3 Rs	Plan 4 Rs	Plan 5 Rs	Plan Rs
Crossbred cow (2000 kg/year)	1774	-	13158	14179	2605
" (2500 kg/year)	2282	-	11258	11965	3953
" (3000 kg/year)	2909	-	8195	8587	4141
Crossbred, heifer	400	-	31035	33719	4299
Buffalo (1500 kg/year)	1515	-	1741	3778	-
" (2000 kg/year)	2052	-	-	-	2075
Ragi (single crop) improved unirrigated, kharif	715	717	743	743	733
Ragi improved irrigated	4588	11937	7322	7322	7247
Groundnut unirrigated, kharif	832	1916	2716	2720	2775
Horsegram unirrigated, kharif	519	1791	1771	1771	2079
Sugarcane	13029	18798	25246	27224	27385
Carrot, kharif	8549	-	-	9357	9357
Carrot, rabi	8549	-	-	9343	9343
Brinjal, kharif	9295	-	-	-	9500
Potato, rabi	9806	-	-	10044	10044
Cucumber, kharif	5679	-	-	9231	9409
Sale of ragi, rabi	99	184	-	186	186
" , summer	99	184	-	157.4	-
Sale of paddy, kharif	112	320	297	298	-
" , rabi	112	120	302	302	302
" , summer	112	315	217	287	287
Sale of maize, kharif	129	-	-	356	-
" , rabi	129	311	-	-	-

6.1.2.3 Disposal Activities:

Human labour unemployed in the plan was the order of 59, 53, 190.6, 65.27, 212.03, 67.05 and 209.41 man days for 1 to 6 periods respectively. This labour could be utilized if the non plan activities, namely, horsegram, groundnut and sugarcane enter the plan with the profit levels higher than the level considered.

6.1.2.4 Opportunity Cost of Non plan Activities:

Other crop activities, horsegram and groundnut on unirrigated land could compete with ragi crop only if they could bring Rs. 1272/ha and Rs. 1084/ha more than the level considered. Similarly sugarcane needed Rs.5770/ha more than existing conditions (Table 6.5). Even under improved technology with liberal credit, only food grains entered the plan.

6.1.2.5 Improvement over the Previous Plan:

By the introduction of improved technological practices the plan enhanced the net return from crop production to Rs. 3299, which is almost double the previous plans 1 and 2 with existing technology. Land utilised under this plan was 155.91 per cent, 32.13 per cent more than the existing condition and 10.82 per cent more than plan 1 and 2 (Table 6.3). As for human labour employment there was little improvement over the previous plans, still below the existing condition where labour utilized was more than optimum plan. The labour utilization under the existing condition was 53.75 per cent whereas, this plan shows 19.55 per cent only. The same trend was observed for bullock labour employment also.

6.1.3 Plan 4 - Improved Crop and Dairy Technology.

Plan 4 considered dairy activities, buffalo and crossbred cows using improved managerial and feeding practices along with crop production. In this plan dairy animals were considered only for milk production. Two buffalo activities, 1500 kg and 2000 kg/year and 4 crossbred cow activities, namely 2000, 2500, 3000 and 3500 kg/year and one heifer activity, were introduced in the matrix. The following were the activities entered in the plan which are presented in Table 6.6

6.1.3.1 Crop Activities:

Ragi crop was assigned 0.38 ha of unirrigated land in kharif season, 0.0595 ha of irrigated land in rabi and 0.194 ha of irrigated land during summer. Out of 12.79 quintals of ragi produced, 2.27 quintals during kharif and 4.52 quintals during summer were shown as sold after meeting consumption requirement at the price level considered for this plan. Thus unlike the previous plan 3, where surplus ragi did not enter market for want of higher price, this plan managed to sell all the surplus stock. No change was observed in paddy cultivation in this plan. Paddy was produced only for home consumption.

Table 6.6: OPTIMUM FARM PLAN 4
Marginal Synthetic Farm

Activities in the plan	Unit of activities	Level of activities
REAL ACTIVITIES		
Crossbred cow (2500 kg/year)	Number	0.0918
Soobabul unirrigated	hectare	0.058
Jowar unirrigated, kharif	"	0.0258
Green fodder	"	0.0287
Ragi unirrigated land, kharif	"	0.38
Ragi irrigated land, rabi	"	0.0595
Ragi irrigated land, summer	"	0.194
Paddy, kharif	"	0.107
paddy, rabi	"	0.107
Paddy, summer	"	0.107
Maize, kharif	"	0.194
Maize, rabi	"	0.135
Ragi selling, kharif	Quintals	2.27
Ragi selling, summer	"	4.52
Maize selling, kharif	"	10.1
Maize sale, rabi	"	6.51
Bullock hire period 1	paid days	7.51
Bullock hire period 3	"	1.36
Bullock hire period 5	"	3.36
Capital borrowing, kharif	Rs. 100s	57.7
Capital borrowing, summer	"	3.51
DISPOSAL ACTIVITIES		
Labour period 1	Man days	59.57
" 2	"	190.80
" 3	"	65.94
" 4	"	207.57
" 5	"	67.1
" 6	"	208
Bullock labour period 2	pair days	2.68
" 4	"	11.62
" 6	"	10.34
Straw	qtls	30.85

Total maize sale over and above home requirement was 16.61 quintals from 0.329 hectare of irrigated land. For green fodder, Napier/guinea grass, 0.0287 ha was kept and soobabul occupied 0.054 ha of unirrigated land. Jowar production meant for feeding the high yielding cows occupied 0.0258 hectare of unirrigated land. Inspite of this fodder production, crossbred cow or high yielding buffaloes could not enter the plan.

6.1.3.2 Dairy Activities:

Just to fulfil the home requirements 0.0918 unit of crossbred cow yielding 3500 kg/year was shown in the plan. Perhaps constraint relaxation by including buying activities for cow milk from market would have removed crossbred cow altogether from the plan. Further details of this poor state of affairs showed that the price for milk and the profit per animal ought to be much higher than what was considered.

6.1.3.3 Added Activities:

In all the peak seasons bullock pairs were hired in this plan. Thus 7.51 days in kharif season, 1.36 days in rabi season and 3.36 days in summer season were the requirement of hired bullock labour. The plan allowed Rs. 5770 for kharif, Rs. 351 for summer as capital borrowed.

6.1.3.4 Disposal Activities:

As may be observed from Table 6.6 the activities in this plan did not fully utilize human labour and bullock labour. Straw unutilized was of the order of 30.85 quintals as no provision was kept in the problem matrix to sell straw.

6.1.3.5 Opportunity Cost of Non plan Activities:

The obvious reason for lower gross income is that crossbred cow or buffalo were shown as competitive with improved crop activities for the resources but not supplementing the income by remunerative prices.

Thus to supplement the income, crossbred cow 2000 kg/year, needed Rs. 11384/year, crossbred cow, 2500 kg/year, Rs. 8976/year, 3000 kg/year, Rs. 5286/year and heifer Rs. 30635 more than the level considered.

This state of affair is possible only if we consider crossbred cow in the cattle market which would fetch higher price than keeping only for milk production. This type of situation is underlined because, as shown by the results of this plan, price of milk in reality cannot be as high as Rs. 5.71/kg.

As for other crops, groundnut would be considered optimum only at Rs. 2716/ha. horsegram at Rs. 1771/ha and sugarcane at Rs. 25246/ha. as against the price of Rs. 832, 519 and 13029/hectare respectively.

6.1.3.6 Improvement over previous plans:

The cropping intensity in this plan was 167.74 per cent. The increase over existing situation was about 42 per cent and over plan 1 and 2, about 16 per cent and over plan 3 only about 8 per cent (Table 6.3). Labour and bullock power were not utilized even as much as in plan 3, but little more than plan 1 and 2. The net income in this plan was less than previous plan, that is, only Rs. 2778, whereas plan 3 brought Rs. 3299 as net return. Except that land is utilized more intensively, no superiority can be attributed to this plan over previous plans.

6.1.4 Plan 5 - Improved Crop Dairy Horticulture Crop Technology.

Plan 5 included horticultural crops grown under improved methods. They were potato, carrot, brinjal and cucumber along with crop and dairy activities of the previous plan 4. Land allotted for ragi, paddy soobabul, jowar and green fodder were kept unaltered. Maize had to sacrifice its area for carrot during summer and brinjal during kharif season resulting in reduction in maize sale to 7.13 quintals. Capital borrowed was Rs. 8610 as against Rs. 6120 in the previous plan. Carrot was allotted 0.135 hectare of land and brinjal 0.166 ha.

6.1.4.1 Disposal Activities:

The labour disposal amounted to 85.2 per cent of unemployed labour. Bullock labour unutilised during

2nd, 4th and 6th period were 1.03, 11.62 and 10.85 bullock pair days respectively. The unutilised straw was 14.2 quintals.

6.1.4.2 Opportunity Cost of non plan Activities:

With the introduction of vegetable crops, the profit level at which non plan activities enter had increased further. Of dairy animals, crossbred cow 2000, 2500, 3000 kg/year needed Rs. 14179, 11965 and 8587 more per year than the level considered at Rs. 1774, 2282 and 2909, respectively. Heifer needed Rs. 33719 as profit to compete with crop. Buffalo needed Rs. 3778 as against Rs. 1741, ragi on irrigated land needed Rs. 7322 rather than Rs. 4588/ha. as net profit. Groundnut, horsegram and sugarcane could be entering the plan if they could fetch Rs. 2728, 1771 and 27224/ha as net profit. Carrot in kharif and rabi season needed Rs. 9357, 9343/ha respectively rather than Rs. 8549/ha; potato would be competing only at Rs. 1004^/ha net return rather than Rs. 9806/ha; and cucumber at Rs. 9231/ha net return rather than Rs. 5679/ha net return.

6.1.4.3 Improvement over the previous plans:

Plan 5 utilized land to the extent of 166.67 per cent which was an improvement over existing condition and plan 1 to 3, but there was no change in the cropping intensity as compared to plan 4. This was the direct result of exchange of area under maize to area under

Table 6.7: OPTIMUM FARM PLAN 5
Marginal Synthetic Farm

Activities in the plan			Unit of activities	Level of activities
REAL ACTIVITIES				
Crossbred cow (2500 kg/year)			Number	0.0918
Soobabul			hectare	0.054
Jowar			"	0.0258
Napier			"	0.0287
Ragi unirrigated, kharif			"	0.30
Ragi irrigated, rabi			"	0.0595
Ragi irrigated, summer			"	0.0595
Paddy, kharif			"	0.107
Paddy, rabi			"	0.107
Paddy, summer			"	0.107
Maize, kharif			"	0.0278
Maize, rabi			"	0.135
Carrot, summer			"	0.135
Brinjal, kharif			"	0.160
Sale of ragi, kharif			quintals	2.27
Sale of maize, kharif			"	7.13
Sale of maize, rabi			"	6.52
Bullock hire period 3			pair day	1.36
Bullock hire period 5			"	3.05
Capital borrowing, rabi			Rs. 100s	75.40
Capital borrowing, summer			"	10.70
DISPOSAL ACTIVITIES				
Labour period	1		Man days	54.76
"	2		"	173.97
"	4		"	207.56
"	5		"	64.59
"	6		"	173.97
Bullock labour period		2	Pair days	1.03
"		4	"	11.62
"		6	"	10.85
Straw			quintals	14.2

carrot and brinjal. Labour was utilised to 24.8 per cent and bullock labour to 51.04 per cent (Table 6.3). The net return with this plan brought about was Rs. 3045, 9.61 per cent more than plan 4 but 7.70 per cent less than plan 3.

6.1.5 Plan 6 - Improved Technology for Crop, Dairy Horticulture and Sericulture.

Plan 6 was intended to give importance to mulberry cultivation and silk worm rearing to produce cocoons. In this effort dairy animals were also encouraged. Plan 6 proposed the following activities to produce a profit of Rs. 4138/year (Table 6.8).

6.1.5.1 Crop Production:

Area under ragi crop (cultivated along with jowar has been reduced to 0.186 ha of unirrigated land and 0.0595 ha of irrigated land during rabi and summer seasons primarily for home consumption only. A very negligible amount of 0.0855 qtls were shown as sold. The inference drawn from opportunity cost of other crop activities were, ragi in unirrigated area had to bring Rs. 17.78 more than what was hoped and ragi in kharif irrigated land to be Rs. 2659 more. The area under paddy was the same as in plan 3,4 and 5. Area under maize had increased to 0.188 ha in kharif and 0.128 ha in rabi seasons generating a surplus of 6.38 qtls and 5.71 qtls in the respective seasons.

Table 6.8: Optimum Plan 6 - Marginal synthetic farm

Activities in the plan	Unit of activities	Level of activities
REAL ACTIVITIES		
Crossbred cow, 2500 kg/year	No	0.316
Sale of cow milk, kharif	Kgs	261
Soobabul, unirrigated	ha	0.186
Jowar, unirrigated, kharif	ha	0.0886
Ragi unirrigated, kharif	ha	0.186
Ragi, rabi	ha	0.0595
Ragi, summer	ha	0.0595
Paddy, kharif	ha	0.107
Paddy, rabi	ha	0.107
Paddy, summer	ha	0.107
Maize kharif	ha	0.188
Maize, rabi	ha	0.128
Sale of ragi, kharif	qtls	0.0855
sale of maize kharif	qtls	9.3
sale of maize rabi	qtls	5.71
Bullock hire period 1	pair days	1.38
Bullock hire period 3	pair days	1.36
Bullock hire period 5	paid days	3.64
Capital borrowing, summer	(Rs. 100 s)	71.7
Carrot, summer	ha	0.128
Mulberry	ha	0.0354
Cocoon	-1500 eggs	0.0943
DISPOSAL ACTIVITIES		
Labour period 2	mandays	10.57
3	"	7.38
4	"	26.44
5	"	6.11
6	"	
Bullock labour 2	paid days	9.10
4	pair days	11.37
6	pair days	10.63
Straw	qtl	24.61

Unirrigated land for soobabul had increased to 0.186 ha from 0.054 in plan 5. The land allotted to jowar was 0.0886 hectare in kharif in this plan. Green fodder cultivation was replaced by carrot and mulberry leaf cultivation alloting 0.128 ha and 0.0354 ha land respectively.

6.1.5.2 Dairy Activities:

Plan 6 showed signs of accomodating high yielding crossbred cow for milk production at marginally higher level than domestic requirement. 0.316 unit of crossbred cow (3500 kg/year) entered producing a surplus of 261 kg in kharif season only. In the other two seasons the surplus (524 kgs) did not enter market for want of higher price.

6.1.5.3 Additional Resources:

10.78 days of bullock labour were hired for undertaking the activities in this plan. Capital was borrowed to the tune of Rs. 7170 only in summer season.

6.1.5.4 Disposal Activities:

The labour intensive cocoon production activity in the plan enabled to reduce unutilised labour to 7.39 per cent. However, bullock labour utilization was decreased and 24.01 qtls.straw was unutilised.

6.1.5.5 Opportunity cost of non plan activities:

The introduction of cocoon production activity increased the chances of dairy animals to enter the plan. Thus a crossbred cow with 2000 kg/year, 2500 kg and 3000 kg/year required only Rs. 2605, 3953 and 4141/year net return. Heifer would be entering of course at Rs. 4299/ year almost 10 times more than what was considered. Buffalo need to have Rs. 2075 to compete with crops. Other non plan activities, namely ragi on irrigated land, groundnut etcetra has almost same opportunity cost as in plan 5.

6.1.5.6 Improvement over previous plans:

Plan 6 which had a clear superiority over other plans with increased utilization of land (195.7 per cent) and labour (92.70 per cent) brought a net income of Rs. 4138 which could be improved if surplus milk could be marketed at a price situation favourable to marginal farmers.

6.1.6 Appraisal of Alternative Farm Plans under Model I.

A marginal farmer in a dry farming area having 0.79 ha of operational holding with 916 man days of family labour at his disposal and limited bullock labour, under existing condition could face negative net return showing the sub optimal level of his farm plan. Model I through its 6 plans was an attempt to recognize the resources by rearranging the production pattern which proved that positive net income could be generated. The best plan from among the alternatives could be selected only after critically assessing their comparative merits and demerits. The comparative production performance of plan 1 through 6 along with existing condition are presented in Table 6.9. Under existing condition, marginal farmers' plan appeared to be 14.36 qtls of ragi, 12.06 qtls of paddy and 1.72 qtls of maize which after fulfilling home requirement brought 8.36 qtls of ragi and 3.06 qtls of paddy for market sale. Milk production after meeting minimum consumption requirement generated marketed surplus of 670 kgs.

The reallocation of resources under plan 1 and 2 produced the same quantities of crop and milk output and identical amounts of products were marketed. The net return these plans would generate was highest at Rs. 8124, 80 per cent of it was due to sale of dry crossbred cows. The sale of two dry crossbred cows under the annual optimal plan border on practical infeasibility making them unacceptable for recommendation. Though plan 3 could attain ragi production of 25.94 qtls after meeting home requirements only 8.09 qtls could be sold leaving the remaining 10.05 qtls idle stock. As for other food grains, paddy production was just enough for home and maize had 12 qtl surplus which was brought to market for sale. The unsold ragi surplus and the price it demanded being twice the existing level were the prominent reasons for the impracticability of plan 3.

Table 6.9: Comparison of optimum plans 1 to 6 interms of important production pattern - marginal farm.

Particulars	Existing plan	Optimum plan					
		Existing Technology		Improved Technology			
		1	2	3	4	5	6
<u>Production</u> (qtls)							
Ragi	14.36	9.25	9.25	25.94	12.79	12.79	6.00
Paddy	12.06	18.30	18.30	9.00	9.00	9.00	9.00
Maize	1.72	1.50	1.50	13.50	18.11	10.98	13.59
Milk (kgs)	992	477	477	-	322	322	1107
<u>Sale</u> (qtls)							
Ragi	8.36	3.25	3.25	8.09	6.79	6.79	-
Paddy	3.06	12.30	12.30	-	-	-	-
Maize	-	-	-	12.00	16.61	9.48	12.09
Milk (kgs)	670	153	153	-	-	-	261

Moreover, dairying being an integral part of Indian farming, marginal farmer may not go for only crop production even with improved technology. Hence plan 3 turned out to be a theoretical optimum plan.

Plan 4, with improved crop and dairy would result in less of ragi and more of maize than in plan 3. The quantity of ragi sold was 6.79 qtls and that of maize 16.61 qtls. High yielding crossbred cow could not enter in its full integer value and could fulfill only home home requirement. This shows the dominance of improved crop production over dairy. Since enhanced milk production through cross breeding programme is the accepted form for marginal farmer, this plan does not represent the ideal situation. Similar was the case with plan 5, where milk production was kept at subsistence level.

The introduction of sericulture in plan 6, brought about a total change in the production pattern. Milk production, enhanced to 1107 kg, only 261 kg of kharif milk was sold out for lack of higher price. The price demanded for the unsold milk in the plan was Rs. 2.11/kg whereas the optimum plan was Rs. 1.60/kg. Judged by resource utilization, namely, land and employment of labour, and output of surplus milk and food grain maize, this plan proved to be ideal among the alternatives for marginal farmers. But the efficiency of this plan need to be tested by fluctuating net returns which would be attempted in model 2 under plan 11 and presented in the chapter that follows.

6.2 SMALL SYNTHETIC FARM

In Bangalore district, while more than half of the farm population belong to marginal farm, one out of 3 or 4 farms is a small farm. Small farmers are identified as a potential force to reckon with from the egalitarian angle. Development prospects for them are constantly being reviewed, reformulated and redefined in the light of changing facts of growth prospects.

In the study area, the small farmers, with an average of 2.00 hectare of cultivable land had taken up mixed farming with crop, milk and to some extent cocoon production subject to the prevailing agronomic, financial and managerial conditions. Attempt has been made in plan 1 and 2 to bring out the axioms of optima under existing practices and plans 3 to 6 are devised to shift small farms to highly improved methods of cultivation in order that the productivity of the limiting resources, land and capital could be increased.

6.2.1 Plan 1 and 2.

Constraints and problem matrix for small farm situation are presented in Appendix IX. Necessitated by integer values for dairy animals, plan 1 and 2 brought 4 possible situations (Table 6.10) namely, situation (i) a combination of one crossbred cow (type 1), one crossbred dry cow and two buffaloes (type 1); situation (ii) one dry crossbred cow, one crossbred heifer, two local cow

Table 6.10: Four alternative situation with integer values for dairy activities for Plan 1 and 2

Small Synthetic Farm

Name of activities	Unit of activity	Situations I	II	III	IV
Crossbred cow, type 1	Number	1	0	0	0
Crossbred cow type 2	"	0	0	1	0
Crossbred cow dry	"	1	1	2	1
Crossbred heifer	"	0	1	0	1
Hallikar cow type 1	"	0	0	0	1
Hallikar cow type 2	"	0	2	0	0
Buffalo milking type 1	"	2	1	1	2
Sale of cow milk, kharif	Kgs	431	158	97	53
" , rabi	"	350	100	48	37
" , summer	"	376	120	67	49
Sale of buffalo milk, kharif	"	352	176	176	352
" , rabi	"	380	190	190	380
" , summer	"	332	166	166	332
Ragi improved variety unirrigated, kharif	"	1.52	1.52	1.52	1.52
Ragi improved irrigated, kharif	"	0.08	0	0	0.05
Ragi improved, summer	ha	0.25	0	0	0.25
Paddy, kharif	"	0.30	0.30	0.30	0.30
Paddy, summer	"	0.24	0.29	0.29	0.24
Maize, kharif	"	0.14	0.14	0.14	0.14
Beet root, rabi	"	0.10	0.21	0.20	0.16
Chilli, rabi	"	0.04	0.02	0.04	0
Grass	"	0.49	0.46	0.48	0.49
Napier	"	0	0.03	0.01	0.0
Sale of ragi	"	5.19	5.02	5.02	6.06
Sale of ragi	"	1.85	0	0	1.88
Sale of paddy	"	10.7	12.9	12.9	10.5
Bullock hire	"	13.0	12.6	12.8	13.2
Bullock hire		0.75	0	0	0.76
Capital borrowing, kharif	Rs. 100s	84.9	87.7	88.5	86.4
" , summer	"	18.8	23.5	23.9	23.9

(type 2) and one buffalo (type 1), situation (iii) one crossbred cow (type 1) two crossbred dry cow, one buffalo (type 1), and situation (iv) one dry crossbred cow, one crossbred heifer, one local cow (type 1) and two buffalo (type 2). Situation (i) brought a net return of Rs. 13367 by spending Rs. 12180 for dairy and crop enterprise in the plan; situation (ii) showed an expenditure of Rs. 12823 and a return of Rs. 14325 over expenditure; situation (iii) expended Rs. 11764 to bring Rs. 14470 return, situation 4 presented possibility of getting Rs. 14613 net income after meeting Rs. 12260 expenditure judged by maximum net return, situation (iv) in plan 1 was taken for explanation (Table 6.11).

6.2.1.1 Crop Activities:

The following are the activities in the plan both for plan 1 and 2. This plan brought a marketed surplus of 7.64 qtls of ragi from 1.52 ha of kharif unirrigated land, 0.0473 ha of irrigated land and 0.355 ha of summer irrigated land. Kharif and summer paddy on 0.301 ha and 0.235 ha respectively produced marketed surplus of 10.5 qtls which were shown as sold. Maize was produced only for home requirement from 0.142 ha of kharif land. Beetroot had occupied 0.155 ha of rabi land and grapes had covered 0.49 ha in each season.

6.2.1.2 Dairy Activities:

One dry crossbred cow, one crossbred heifer and one local bred cow type 1 and two buffaloes type 1

Table 6.11: Activities in Optimum Plan 1 and 2

Small Synthetic Farm

Name of activities	Unit of activity	Level of activities
REAL ACTIVITIES		
Crossbred cow dry	Number	1
Crossbred Heifer	"	1
Hallikar cow type 1	"	1
Buffalo type 1	"	2
Sale of cow milk, kharif	Kgs.	53
" , rabi	"	37
" , summer	"	49
Sale of buffalo milk, kharif	"	352
" , Rabi	"	380
" , Summer	"	332
Ragi improved variety unirrigated, kharif	hectare	1.52
Ragi improved variety irrigated, kharif	"	0.0473
" , summer	"	0.255
Paddy " , Kharif	"	0.301
Paddy " , Rabi	"	0.235
Maize " , Kharif	"	0.142
Beetroot " , rabi	"	0.155
Grapes	"	0.49
Hired bullock, kharif peak season	pair days	13.2
" rabi peak season	"	0.755
Borrowed capital, kharif	Rs.100's	86.4
" , summer	"	23.9
Sale of ragi, kharif	quintals	6.06
Sale of ragi, summer	"	1.88
Sale of paddy, summer	"	10.5
DISPOSAL ACTIVITIES		
Labour period 1	man days	26.69
" 2	"	66.56
" 3	"	36.40
" 4	"	125.30
" 6	"	107.9

Contd...

Plan 1 and 2, devoid of cattle marketing, could generate a gross margin of Rs. 9205 whereas with improved crop technology plan 3 could fetch a net profit of only Rs. 4993.

6.2.3 Plan 4.

The activities and their level in optimum plan 4 are presented in Table 6.15. A total of 25.19 qtl of ragi was produced from 1.17 ha of unirrigated and 0.2703 ha of irrigated land. The surplus for sale after meeting the home requirements was 13.09 qtl. Paddy crop was allotted just enough area to meet the family needs, that is 0.143 ha in each season. Land allotted for maize could produce 15.16 qtls in total from 0.181 ha and 0.0918 ha of irrigated land during kharif and rabi seasons, and the surplus for sale was of 3 qtl and 12.16 qtls respectively.

6.2.3.1 Dairy Activities:

Milk production was taken up only to meet the home requirement which worked out to 0.116 unit of crossbred cow (yielding 3500 kg/year) inspite of the attempt to obtain integer value for cow unit. To feed this 0.116 unit of cow, 0.0682 ha and 0.0362 ha of unirrigated land for soobabul and jowar and 0.0362 ha of irrigated land for green fodder cultivation were allotted in this plan. This plan made use of 3.29 days of hired bullocks and Rs. 7791 of borrowed capital.

Table 6.15: Optimum Farm Plan 4

Small Synthetic Farm

Activities in the Plan	Unit of activity	Level of activities
REAL ACTIVITIES		
Crossbred cow, 3500 kg/year	Number	0.116
Soobabul unirrigated	hectare	0.0682
Jowar unirrigated, kharif	"	0.0325
Napier	"	0.0362
Ragi unirrigated, kharif	"	1.17
Ragi irrigated, rabi	"	0.0893
Ragi irrigated, summer	"	0.181
Paddy, kharif	"	0.143
Paddy, rabi	"	0.143
Paddy, summer	"	0.143
Maize, kharif	"	0.181
Maize, rabi	"	0.0918
Sale of ragi, kharif	quintal	10.1
Sale of ragi, summer	"	3.08
Bullock labour hired, period 1	Pair days	3.29
Sale of maize, kharif	quintal	9.29
Sale of maize, rabi	"	3.87
Capital borrowing, kharif	Rs. 100's	68.9
Capital borrowing, rabi	"	3.35
Capital borrowing, summer	"	5.66
DISPOSAL ACTIVITY		
Labour period 1	Man days	46.72
" 2	"	163.5
" 3	"	65.85
" 4	"	209.46
" 5	"	66.98
" 6	"	208.80

Contd....

Table 6.15 continued

Activities in the Plan		Unit of activity	Level of activities
Bullock labour	3	Pair days	11.63
"	4	"	54.33
"	5	"	9.45
"	6	"	53.03
Napier		quintal	24.1
Maize khadbi		"	24.74

6.2.3.2 Disposal activities:

There were 59.29 per cent of unutilised labour distributed over the entire period. Other unutilised resources consisted of bullock labour days, green fodder and straw.

6.2.3.3 Non plan activities:

To compete with the essential food crops like ragi, paddy and maize cultivated with improved technology, crossbred cow yielding 2000 kg, 2500 kg and 3000 kg/year, needed very high profit levels. Thus cows with the above milk production potential needed Rs. 13504, 11498 and 8328/year as net return respectively. Similar was the case with crossbred heifer which needed Rs. 31944/year than that shown in the matrix. Buffalo milk production with 2000 kg, showed only marginal difference in net return to enter the optimum plan, with Rs. 1741/year as compared to Rs. 1515/year. All other non plan crop activities except sugarcane were having more or less same opportunity cost as in plan 3.

Sale of rabi ragi would be undertaken at Rs. 177/qtl, kharif paddy at Rs. 297/qtl, rabi paddy at Rs. 291/qtl and summer paddy at Rs. 196/qtl rather than at the uniform rate of Rs. 112/qtl.

6.2.3.4 Improvement over previous plan:

Plan 4 could improve land utilisation to the extent of only 14.57 per cent over the existing condition. The cropping intensity was only 117.82 per cent, labour utilization 40.71 per cebt and 25.77 per cent of the bullock power was utilized. The plan could generate a net income of only Rs. 3662 which is lower than that generated by the first three plans.

6.2.4 Plan 5.

When the horticultural crops were added as plan alternative, the irrigated land under ragi and maize was partially replaced by carrot and brinjal. This type of re-adjustment could enhance the profit by Rs. 177 over the previous plan 4. Under the reallocation of land brought out in this plan (Table 6.15) area under summer ragi and kharif maize was reduced to 0.0893 ha and 0.0282 ha from 0.181 ha each to be alloted for carrot and brinjal. This type of change curtailed the sale of ragi and maize to 10.1 qtl and 3.86 qtl respectively. All the other activities of plan 4 remained unaltered.

6.2.4.1 Disposal activities in the plan:

This plan while increasing the bullock labour utilization saved labour to the extent of 79.36 per cent. Bullock labour disposal during periods 2,3, and 6 were 37.78, 11.68 and 53.68 bullock pair days respectively. A totalof 9.45 qtls of straw were shown as stock.

Table 6.16: Optimum Farm Plan 5

Small Synthetic Farm

Activities in the Plan	Unit of activity	Level of activities
REAL ACTIVITIES		
Crossbred cow, 3500 kg/year	Number	0.116
Green fodder	hectare	0.0362
Soobabul unirrigated	"	0.0682
Jowar unirrigated, kharif	"	0.0325
Ragi unirrigated, kharif	"	1.17
Ragi irrigated, rabi	"	0.0893
Ragi irrigated, summer	"	0.0893
Paddy, kharif	"	0.143
Paddy, rabi	"	0.143
Paddy, summer	"	0.143
Maize, kharif	"	0.0282
Maize, rabi	"	0.0918
Carrot, kharif	"	0.0916
Brinjal, kharif	"	0.153
Ragi sale	quintals	10.1
Maize sale	"	2.9
Maize sale	"	3.86
Capital borrowing rabi	Rs. 100's	10.6
Capital borrowing, summer	"	3.86
DISPOSAL ACTIVITIES		
Labour period 1	man days	42.29
" 2	"	148.0
" 3	"	65.84
" 4	"	209.0
" 5	"	65.26
" 6	"	199.80
Bullock labour period 2	pair days	37.98
" 3	"	11.63
" 6	"	53.68
Maize khadibi	quintal	9.45

6.2.4.2 Non plan activities:

As in the case of plan 4, the extremely high level of net profit for other dairy animals continued to impede their entry in the optimum plan as evident from Table 6.13.

The price/kg of milk needed for milk production was Rs. 5.89 which is evidently unrealistic. The reason for this is the absence of cattle marketing as an activity. When dairy activities were to compete with highly remunerative crop enterprises through profits from milk production only, milk prices had to be too high to realise. Other non plan activities assumed more or less same profit level as in plan 4 except for the price of rabi ragi at Rs. 156/qtl and kharif maize at Rs. 281/qtl.

6.2.4.3 Improvement over previous plan:

The plan did not indicate much improvement over the existing condition as regards land utilization. The cropping intensity was 121.94 per cent, an improvement of 18.58 per cent over the existing condition. The net return generated by this plan was Rs. 3839, much lower than plan 1 through 3.

6.2.5 Plan 6.

Plan 6 showed prospects of net return of Rs. 5006.74 by including crop, dairy, horticultural crop and sericulture which formed alternative farm situation under improved technology (Table 6.19). Allocation of 1.02 ha land for kharif unirrigated and 0.0893 ha

Table 6.17: Optimum Farm Plan 6

Small Synthetic Farm

Activities in the Plan	Unit of activities	Level of activities
REAL ACTIVITIES		
Crossbred cow, 3500 kg/year	Number	0.287
Cow milk sale, kharif	Kgs.	200
Jowar unirrigated, kharif	hectare	0.0807
Soobabul unirrigated	"	0.169
Ragi unirrigated, kharif	"	1.02
Ragi irrigated, rabi	"	0.0893
Ragi irrigated, summer	"	0.0893
Paddy, kharif	"	0.143
Paddy, rabi	"	0.143
Paddy, summer	"	0.143
Maize, kharif	"	0.185
Maize, rabi	"	0.0957
Carrot	"	0.0957
Mulberry	"	0.0322
Cocoon	"	0.0859
Ragi sale, kharif	quintals	8.43
Maize sale, kharif	"	9.22
Maize sale, rabi	"	3.79
Labour hire period 2	man days	85.5
Bullock labour hire period 1	Pair days	2.37
DISPOSAL ACTIVITIES		
Labour period 3	man days	19.93
" 4	"	67.78
" 5	"	19.3
" 6	"	59.85
Bullock labour period 2	pair days	41.12
" 3	"	11.5
" 4	"	54.1
" 5	"	9.53
" 6	"	53.39
Straw - maize khadibi	quintal	21.78

Table 6.18: Opportunity cost of non-plan activities at improved technology

Small Synthetic Farm (in rupees)

Name of Non-plan activities	Profit/price considered in the plan	Profit/Price at which Non-plan activities start competing the plan activity			
		Plan-3	Plan-4	Plan-5	Plan-6
Crossbred cow, 2000 kg/year	1774	-	13504	14499	2693
" 2500 kg/year	2282	-	11498	12186	-
" 3000 kg/year	2909	-	8320	8709	4176
" Heifer	400	-	31944	34559	4505
Buffalo 1500 kg/year	1515	-	1741	1741	-
" 2000 kg/year	2052	-	-	-	2067
Saleof cow milk, kharif	1.55	-	5.67	5.69	-
Ragi (single crop) improved unirrigated	715	740	743	743	733
Ragi improved irrigated	4588	7611	7309	7322	7248
Groundnut unirrigated	832	2585	2720	2720	3492
Horsegram unirrigated	519	1794	1771	1771	2071
Sugarcane	13029	14117	25917	27843	27997
Carrot, kharif	8549	-	-	9356	9438
Carrot, rabi	8549	-	-	9287	9287
Brinjal, kharif	9295	-	-	-	9492
Potato, rabi	9806	-	-	10044	12185
Cucumber, kharif	5679	-	-	9231	-
Sale of ragi, rabi	99	198	177	0	177
Sale of paddy, kharif	112	294	297	297	297
Sale paddy, rabi	112	298	291	291	291
Sale paddy, summer	112	298	196	264	264
Sale of maize, kharif	129	-	-	289	-
Sale of maize, rabi	129	-	-	-	-

irrigated land each during rabi and summer seasons for ragi produced a surplus of 8.43 qtl for sale after consumption requirements. Minimum shadow price for kharif rabi and summer ragi was Rs. 112.84, 147.06 and 191.81 respectively. An area of 0.143 ha was kept in each season for paddy to meet family requirements. Maize occupied 0.185 ha and 0.0957 ha of land in kharif and rabi generating a saleable surplus of 15 qtl.

6.2.5.1 Dairy Activities:

High yielding crossbred cow (3500 kg/year) entered the plan producing 1004 kg (0.287 unit) of which 200 kgs were sold in kharif season, but the surplus of 400 kg in the other seasons was kept in disposal activity. To meet the feed requirement unirrigated land of the order of 0.169 ha for soobabul and 0.0807 ha for jowar was earmarked. Carrot in summer season became a possibility in this plan with 0.0957 ha and 0.0322 ha was kept for mulberry for 0.0859 unit of cocoon production. Other crop activities like groundnut, horsegram, sugarcane brinjal, etcetra did not enter the plan for want of much higher profit level.

6.2.5.2 Additional resources:

This plan made use of 2.37 days of hired bullock labour and 85.5 days of human labour to undertake the activities envisaged.

6.2.5.3 Disposal activities in the plan:

Plan 3 to 6 were parameterised with level of resource available with farmers to get optimum plans. Hence the results of plan 6 under all farm conditions showed improvement to the same extent as in marginal or other farm situations. Like marginal farms, in small farm also, under this plan, labour utilization was maximum leaving for disposal only 18 per cent. This plan showed improvement of 18.24 per cent over existing conditions when land utilization was considered. The net return arrived by this plan was Rs. 5007, an increase of 9.27 per cent over existing conditions.

6.2.5.4 Appraisal of alternative plans under Model I:

Table 6.19 brings out the comparative statement of production pattern under various optimum plans. A perusal of this table and the table where utilization of resources were brought out, could help to visualise the ideal optimum plan for small farmers.

A small farm having 2.00 ha of land for cultivation under existing practice utilized land upto 88.67 per cent generating net profit of Rs. 4582. Milk was the only product with marketed surplus of 1200 kgs while food grains were only sufficient for family consumption.

The situation under went drastic improvement by introducing plan 1 and 2 where land utilization rose

Table 6.19: Comparison of optimum plan 1 to 6 in terms of important production pattern - small farm

Particulars	Existing plan	Optimum plan					
		Existing Technology			Improved Technology		
		Plan-1	Plan-2	Plan-3	Plan-4	Plan-5	Plan-6
PRODUCTION (QTLS)							
Ragi	12.7	19.94	19.94	53.43	25.09	22.1	20.43
Paddy	5.88	16.38	19.38	9.00	9.00	9.00	9.00
Maize	1.74	3.00	3.00	22.6	15.16	6.86	18.0
Milk, kgs	1623	1618	1618	-	415	415	1004
SALES (QTLS							
Ragi	0.7	7.94	7.94	24.9	13.09	10.1	8.43
Paddy	-	10.5	10.5	19.00	-	-	-
Maize	-	-	-	19.6	12.16	3.86	15.0
Milk, kgs	1208	1203	1203	-	-	-	200

to 153.5 per cent and labour 61.06 per cent and production increased considerably to create marketed surplus of ragi (7.94 qtl) paddy (10.5 qtls) and milk (1203 kg) assuring a net income as high as Rs. 14613.

Plan 3 faced the handicap that it could not bring all the surplus produce to market owing to the inability to face market competition and could not be regarded ideal inspite of showing Rs. 4999 as net income.

In plan 4 and 5, milk production could not exceed home requirement constraint and also the labour and land utilization for the activities in the plan were much less than that in the other plans.

Finally, plan 6 produced milk for market sale. But for the price disadvantage during rabi and summer, all the surplus milk (600 kg) would have been sold out. Judged by the greater utilization of land and labour and income generating capacity plan 1 and 6 were kept as ideal for small farmers under risk neutral conditions.

6.3 MEDIUM SYNTHETIC FARM

Medium and large farmers of Bangalore district constitute 16.27 per cent of the farming community cultivating 46.51 per cent of the total cultivable land. Optimal solutions, whether under Model I or II, would not only improve the conditions of this elite farm group by better utilization of resources and stabilizing the farm income, but also have considerable impact on the farming society as a whole.

6.3.1 Plan 1 and 2.

Constraints and problem matrix for medium synthetic farm situation are presented in Appendix X. Plan 1, with crop and dairy under existing technology assured a net profit of Rs. 23557 with the level of activities presented in Table 6.20.

6.3.1.1 Crop Activities:

The plan utilized 2.14 hectare of unirrigated land for ragi local variety during kharif season and 0.315 ha. in rabi season and 0.378 ha in summer season producing 32.22 qtl.Kharif ragi to the extent of 16 qtls were sold at the existing price, thereby leaving 16.22 qtl for home. In order to have flexibility in the constraint of minimum requirement, buying of paddy in all the 3 seasons was incorporated in the plan. As a result, land was allotted for paddy only in kharif and summer seasons (0.366 ha. and 0.114 ha. respectively) yielding 14.59 qtl of which 4.59 qtl were shown as sale in the two seasons. The purchase of paddy during rabi season at rates lower (Rs. 106/qtl) than the sale price (Rs. 134/qtl) in kharif amounted to 5.0 qtl. Land allotted for maize in kharif and rabi seasons was 0.24 ha to meet the family requirement only. Grape cultivation, though undertaken for a

Table 6.20: Optimum Farm Plan 1 and 2

Medium Synthetic Farm

Activities in the plan	Unit of activity	Level of activities
REAL ACTIVITIES		
Crossbred cow milking type	Number	2
" Dry	"	2
Crossbred heifer	"	2
Sale of cow milk - kharif	Kgs	333
" Rabi	"	333
" Summer	"	93
Ragi local variety on unirrigated land, Kharif	Hectare	2.14
Ragi improved, rabi	"	0.316
Ragi improved, summer	"	0.378
Paddy, kharif	"	0.366
Paddy, summer	"	0.114
Maize, kharif	"	0.126
Maize, rabi	"	0.176
Grapes	"	0.596
Green fodder	"	0.0226
Labour hire period 1	Mandays	29.9
Bullock labour hire period 1	Pair days	8.58
Capital borrowing, rabi	Rs. 100's	16.3
Capital borrowing, summer	"	146.00
Purchase of paddy, rabi	Qtls	5.0
Sale of ragi, kharif	"	16.0
Sale of paddy, kharif	"	0.45
Sale of paddy, summer	"	0.14
DISPOSAL ACTIVITIES		
Labour period 2	Mandays	153.33
" 3	"	36.71
" 4	"	362.07
" 5	"	45.63
" 6	"	258.52
Bullock labour period 2	Pairdays	51.26
" 3	"	20.72
" 5	"	24.65
" 6	"	99.58

Table 6.20 (continued)

Activities in the plan	Unit of activity	Level of activities
Ragi straw	Quintals	23.06
Paddy straw	"	0.72
Maize khadibi	"	0.4128

period of at least 5 to 6 years, its annual variable cost was comparatively high. In view of this, it was kept as one of the competing activity, and found to occupy 0.506 ha. Napier cultivation to feed the dairy cows as per the plan would occupy 0.0226 ha.

6.3.1.2 Dairy Activities:

A total of 6 crossbred cows (all having market value with profit margin), two milch cow type II, two dry cows and two heifers entered the plan with marketed surplus of 759 kg milk and adding Rs. 14644 to profit.

6.3.1.3 Additional Resources:

In order to utilize fully the restrictive resources and to ensure maximum return from the capital invested, this plan made use of 8.58 pair of days of hired bullock labour and 29.9 days of hired human labour. Capital borrowed was Rs. 1630 and 14600; during rabi and summer seasons respectively.

6.3.1.4 Disposal Activities:

The unutilised resources in the plan constituted of 48.5 per cent of human labour distributed over the six periods and bullock labour to the extent of 47.82 per cent. Dry fodders such as ragi straw (23.06 qtls), paddy straw (4.72 qtls) and maize khadibi (0.4128 qtls) were shown as stock.

6.3.1.5 Non-plan Activities:

Opportunity costs (Table 6.21) of improved ragi on unirrigated land could have competed with a higher profit margin of Rs. 158.12/hac. more and irrigated crop of the same variety with Rs. 1876.5/ha.more. Judged by this, the former, became the next best for the plan. However, the land allotment for paddy was likely to change if kharif paddy local started competing with the activity in the plan with Rs. 1261/ha. profit than Rs. 529/ha; and rabi crop with Rs. 3944/ha. than with Rs. 2064/ha. However, this plan would be changed if the non-plan dairy and crop activities improved their return/ unit. From Table 6.21 it is clear that crossbred cow type 1 and buffalo type 1 became the next competing dairy activity to enter and among crops, horsegram and groundnut on unirrigated land and tomato and potato on irrigated land.

Owing to the low profit level of all the 3 varieties of cocoons, plan 2 did not improve the optimal solution. The opportunity cost for cocoons indicated that local, medium and large variety were to fetch Rs. 13984, 14003 and 14109 more to compete with the optimal solution (Table 6.21). This situation become remote and hence silk worm rearing for optimal solution was ruled out.

Table 6.21: Opportunity cost of non-plan activities under existing technology of Medium Farm

Name of non-plan activity	Existing price/ profit level Rs	Profit/price at which activity compete with optimum plan Rs
Crossbred cow type 1	624	787
Hallikar cow type 1	658	1720
Hallikar cow type 2	863	1392
Hallikar cow dry	787	2579
Hallikar Heifer	317	2413
Buffalo type 1	423	640
Buffalo dry	553	3099
Buffalo Heifer	462	3679
Sale of cow milk/kg summer	1.60	3.16
Ragi improved unirrigated,kharif	709	2586
Paddy local, kharif	529	1261
Paddy improved, rabi	1282	3163
Horsegram, kharif	519	1237
Potato, rabi	1567	5184
Sugar cane	7138	14535
Tomato, rabi	1226	4675
Groundnut unirrigated, kharif	685	1808
Beans	1940	6471
Sale of ragi, rabi	102	261
Sale of ragi, summer	99	373
Sale of maize, kharif	109	144
Sale of maize, rabi	150	255
Cocoon small variety	3323	17307
Cocoon medium variety	2431	16434
Cocoon large variety	9559	23668
Ragi straw buying	40	11.2

6.3.1.6 Improvement over existing conditions:

By increasing utilization of resources, this plan could generate Rs. 23557 net return, that is, 4.35 times the existing level. This return was cautiously put-forth owing to the fact that 62 per cent of it is accrued from cattle marketing (Table 6.22). The unutilized ragi straw (23.06 qtls), paddy straw (4.72 qtls) and maize khadibi (0.4128) were shown in disposal activity since the plan had no provision for selling straw in the market. Land utilization over existing conditions increased from 103 per cent to 124 per cent. However, labour employment declined to 51.49 per cent from 72.55 per cent.

6.3.2 Plan 3.

The level of crop activities with improved technology is presented in Table 6.23. It could generate Rs. 16705 net profit.

6.3.2.1 Crop Activities:

Ragi occupied 2.14 hac of unirrigated land in kharif, 0.781 ha. of irrigated land in rabi and 0.831 ha in summer season. Out of 105.72 qtl of ragi, 16.22 qtls were kept for family and 45.8 qtls was the kharif season sale. The remaining 21.3 qtl in rabi season and 22.9 qtls in summer were put in disposal activity for want of higher price level. Allocation of land for paddy crop was only 0.189 ha in each season to fulfil the family needs. This plan made provision for

Table 6.22: Comparision of optimum plans (Model 1) with existing conditions in terms of utilization of resources and net income

Medium Synthetic Farm

Name of resource	Existing conditions	Optimal Plans					
		1	2	3	4	5	6
A. Land							
i) Total cropped area	3.81	4.7258	4.7258	5.1993	6.378	6.378	5.294
ii) Cropping intensity	103.41	124.08	124.04	136.46	167.40	167.40	138.95
Improvement over existing (percentage)	-	24.04	24.04	36.46	67.4	67.4	38.95
B. Labour utilized(man days)	965 (72.55)	678 (51.49)	678 (51.49)	304 (23.08)	315 (23.91)	451 (34.2)	822 (62.39)
C. Bullock labour utilized (pair days)	236 (57.26)	215 (52.18)	215 (52.18)	133 (32.28)	114 (27.23)	117 (27.96)	108 (26.02)
D. Capital mobilized	12849	16680	16680	9165	10525	11313	17211
E. Net income generated	5408	23557	23557	16705	18253	19672	21133
Percentage of income from cattle marketing	20.47	62.16	62.16	-	-	-	-

Table 6.23: Optimum Farm Plan 3

Medium Synthetic Farm

Activities in the plan	Unit of activities	Level of activities
REAL ACTIVITIES		
Ragi unirrigated, kharif	hectare	2.14
Ragi irrigated, rabi	"	0.781
Ragi irrigated, summer	"	0.831
Paddy, kharif	"	0.189
Paddy, rabi	"	0.189
Paddy, summer	"	0.189
Maize, kharif	"	0.831
Maize, rabi	"	0.0493
Bullock labour hire period 1	pair days	9.93
Capital borrowing, rabi	Rs. 100's	41.4
Capital borrowing, summer	"	17.8
Ragi sale, kharif	Quintals	45.8
Maize sale, kharif	"	47.5
DISPOSAL ACTIVITIES		
Labour period 1	Man days	45.9
" 2	"	294.5
" 3	"	76.1
" 4	"	386.8
" 5	"	83.2
" 6	"	380.4
Bullock labour 2	Pair days	66.7
" 3	"	9.5
" 4	"	87.8
" 5	"	14.4
" 6	"	99.9
Ragi for sale, rabi	quintals	21.3
" , summer	"	22.9

sale of 47.5 qtl of maize in kharif season by allotting 0.831 hac. But in rabi the area under the crop was limited to produce 3 qtl for home requirements.

6.3.2.2 Additional resources:

Hired bullock pair labour of 9.93 days and capital borrowing to the tune of Rs. 4140 in rabi and Rs. 1780 in summer was resorted to arrive at the optimal solution. Among the non-plan crops groundnut would be entering if the profit level were to increase by Rs.1084/ha. followed by horsegram by Rs. 1272/ha in unirrigated land. Sugarcane needed Rs. 6701/ha to compete with the existing cropping pattern (Table 6.27). This plan assured Rs. 16705 as net profit only from crops using 136.51 per cent land, 23.01 per cent labour and 32.25 per cent bullock labour.

6.3.3 Plan 4.

Advanced technology in crop and dairy enterprise combination, if operated optimally, would yield Rs. 18253 as net return for the resource endowment of medium farms situation (Table 6.24).

6.3.3.1 Crop Activities:

A total of 1.925 ha. land consisting irrigated and unirrigated, supplied 38.69 qtls of ragi of which the surplus (22.47 qtls) was shown as sold. No change in the acreage under paddy was noticed as compared to plan 3.

Table 6.24: Optimum Farm Plan 4

Medium Synthetic Farm

Activities in the Plan	Unit of activity	Level of activity
REAL ACTIVITIES		
Crossbred cow (3500 kg/year)	Number	1
Cow milk sale, kharif	Kgs	232
Soobabul	Hectare	0.589
Jowar	"	0.281
Green fodder	"	0.313
Ragi unirrigated, kharif	"	1.27
Ragi irrigated, rabi	"	0.137
Ragi irrigated, summer	"	0.518
Paddy, kharif	"	0.189
Paddy, rabi	"	0.189
Paddy, summer	"	0.189
Maize, kharif	"	0.518
Maize, rabi	"	0.381
Ragi sale, kharif	qtls	9.67
Ragi sale, summer	"	12.8
Maize, kharif	"	26.7
Maize, rabi	"	18.3
Bullock labour hire	pair days	4.44
Capital borrowing, summer	Rs. 100's	37.5
DISPOSAL ACTIVITIES		
Labour period 1	Man days	45.97
" 2	"	294.80
" 3	"	78.68
" 4	"	372.2
" 5	"	83.7
" 6	"	37.8
Bullock labour 2	pair days	68.64
" 3	"	17.48
" 4	"	97.48
" 5	"	15.24
" 6	"	100.4
Capital rabi	Rs.	959.00
" summer	Rs.	304.6
Straw	qtls	138.9

Marketed surplus of 45 qtls of maize was produced on 0.899 ha. of irrigated land (0.518 ha in kharif, 0.381 ha in rabi). To feed one crossbred dairy cow (3500 kg/year), 0.589 ha of unirrigated land was kept for soobabul trees, 0.281 ha unirrigated land in kharif for jowar and 0.313 ha of irrigated land in each season was kept for green fodder, napier grass.

6.3.3.2 Dairy Activities:

The plan envisaged one high yielding crossbred cow. Yet milk sale was only 232 kg in kharif season. Non plan animals which would enter next in the plan was crossbred cow yielding 3000 kg/year since the opportunity cost indicated that by increasing profit by Rs. 4908/year (Table 6.27)

6.3.3.3 Additional Resources:

Hired bullock labour (4.44 days) were utilized and Rs. 3750 was borrowed to undertake the plan. Plan 4 brought prospects of Rs. 18253 for medium farm by utilizing 167.4 per cent land, 23.91 per cent human labour and 27.23 per cent bullock labour.

6.3.4 Plan 5.

Entry of horticultural crops grown on improved methods, demanded irrigated land for carrot during summer season (Table 6.25) replacing ragi. The reallocation of land in the plan produced Rs. 19672 net

Table 6.25: Optimum Farm Plan 5
Medium Synthetic Farm

Activities in the Plan	Unit of activity	Level of activities
REAL ACTIVITIES		
Crossbred cow (3500 kg/year)	Number	1
Sale of cow milk kharif	Kgs.	232
Subabul unirrigated	hectare	0.589
Jowar unirrigated	"	0.281
Green fodder irrigated	"	0.313
Ragi unirrigated, kharif	"	1.27
Ragi irrigated, rabi	"	0.137
Ragi irrigated summer	"	0.137
Paddy kharif	"	0.189
Paddy, rabi	"	0.189
Maize kharif	"	0.518
Maize rabi	"	0.381
Paddy summer	"	0.189
Ragi sale kharif	quintals	9.67
Maize sale kharif	"	26.7
Maize sale rabi	"	18.3
Carrot summer	hectare	0.381
Bullock labour hire period 1	Man days	9.67
Capital borrowing kharif	Rs. 100's	39.9
DISPOSAL ACTIVITIES		
Labour period 1	Man days	25
" 2	"	221.4
" 3	"	78.69
" 4	"	372.2
" 5	"	71.25
" 6	"	221.40
Bullock labour period 2	Pair days	61.47
" 3	"	17.48
" 4	"	97.5
" 5	"	16.7
" 6	"	102.84
Straw	quintals	66.27

return increasing capital borrowing to Rs. 5800 and keeping other activities unaltered.

6.3.5 Plan 6.

The comparative advantage of sericulture and horticultural crop over dairy enterprise restructured the level of enterprise combination and reshuffled the resources. This plan brought Rs. 21133 as net profit (Table 6.26).

6.3.5.1 Crop Production:

Ragi on unirrigated land was increased to 1.85 ha from 1.27 ha in the previous plan resulting in a spurt in kharif ragi sales to 16.1 qtl from 9.67 qtls. Paddy cultivation remained unaltered as compared to previous plan. Maize had been slightly increased both by area under culti ation and sale. In kharif season 0.582 ha and in rabi season 0.445 ha was allotted producing 56.4 qtl of maize for sale over and above home requirement. There had been considerable decrease in the area under soobabul, 0.294 ha. as against 0.589 ha. in the previous plan. This was because of the fact that low yielding (2000 kg/year) crossbred cow entered the plan instead of high yielder, eliminating jowar and green fodder cultivation. Carrot cultivation had increased to 0.445 ha. This plan made provision

Table 6.26: Optimum Farm Plan 6
Medium Synthetic Farm

Activities in the Plan	Unit activity	Level of activities
REAL ACTIVITIES		
Crossbred cow (2000 kg/year)	Number	1
Sodbabul	hectare	0.294
Ragi unirrigated, kharif	"	1.85
Ragi irrigated, rabi	"	0.137
Ragi irrigated, summer	"	0.137
Paddy, kharif	"	0.189
Paddy, rabi	"	0.189
Paddy summer	"	0.189
Maize kharif	"	0.582
Maize rabi	"	0.445
Ragi sale kharif	quintals	16.1
Maize sale kharif	"	32.4
Maize sale rabi	"	24
Labour hire period 1	Man days	2.05
Bullock labour period	Pair days	5.85
Capital borrowing rabi	Rs. 100's	56.3
Capital borrowing summer	"	38.4
Carrot summer	hectare	0.445
Mulberry	"	0.249
Cocoon	"	0.664
DISPOSAL ACTIVITIES		
Labour period 2	Man days	155.31
" 3	"	30.69
" 4	"	230.33
" 5	"	25.98
" 6	"	177.13
Bullock labour period 2	Pair days	70.35
" 3	"	17.22
" 4	"	97.10
" 5	"	16.41
" 6	"	162.51
Straw	quintals	133.19

for mulberry cultivation on 0.249 ha of land to be utilized for 0.664 unit of cocoon production (996 eggs) and dairy animal.

6.3.5.2 Additional Resources:

Additional resources hired/borrowed were 5.85 days of bullock labour 2.05 days of human labour and Rs. 9470 of capital. Plan 6, as compared to plan 4 and 5 could utilize land only to the extent of 138.95 per cent but labour employment had risen to 62.39 per cent. The profit level which this plan reached was Rs. 21133.

6.3.6 Appraisal of Alternative Plans under Model I.

A medium farmer with 3.68 ha of land to operate and 1316 mandays of labour at his disposal could raise his income to a much higher level than what he was earning. His plan could provide him only Rs. 5408 as net income. By reallocating his resources to the most profitable enterprise combination, all the plans increased the net return. Plan 1 and 2 brought Rs. 23557, plan 3 Rs. 16705, plan 4 Rs. 18253, plan 5, Rs. 18672 and plan 6, Rs. 21133. Yet a careful examination of the production pattern and resource utilization in the alternative plans would reveal that plan 6 can be considered the best for medium farmer. Under this plan, output was sufficient to have marketed surplus of food-grains and milk with maximum utilization of land, labour and capital (Table 6.28).

Table 6.27: Opportunity cost of non-plan activities at improved technology - Medium Farm.

Name of Non-plan Activities	Profit/price considered in the plan	Profit/price at which activity enter the optimum plan			
		3	4	5	6
Crossbred cow (2000 kg/year)	1774	-	12327	14499	2621
" (2500 kg/year)	2282	-	10614	12187	3956
" (3000 kg/year)	2909	-	7817	8789	4142
Crossbred Heifer	400	-	15649	34689	3382
Buffalo (1500 kg/year)	1515	-	5004	1741	1733
Sale of cow milk kharif season	1.55	-	5.32	6.07	-
" Rabi season	1.55	-	-	-	-
Ragi (single crop) improved unirrigated	715	717	740	743	743
Ragi improved irrigated	4588	-	6611	7322	7171
Groundnut unirrigated	832	1916	2584	2720	2766
Horsegram unirrigated	519	1791	1795	1771	2079
Sugarcane	13029	19030	21734	27843	27648
Carrot, kharif	8549	-	-	9366	9283
Carrot, rabi	8549	-	-	9286	9138
Brinjal kharif	9295	-	-	-	9335
Potato rabi	9806	-	-	10044	-
Cucumber kharif	5679	-	-	9231	9457
Sale of ragi, rabi season	99	184	-	178	176
Sale of ragi, summer season	99	184	-	156	156
Sale of paddy, kharif	112	351	318	297	292
Sale of paddy, rabi	112	414	253	291	287
Sale of paddy, summer	112	295	183	267	265
Sale of maize, kharif	129	-	-	151	-
Sale of maize, rabi	129	320	-	-	-

Table 6.28: Comparision of optimum plan 1 to 6 in terms of important production pattern - Medium Farm.

Particulars	Existing plan	Optimum Plan					
		Existing Technology			Improved Technology		
		1	2	3	4	5	6
PRODUCTION (qtls)							
Ragi	21.8	32.22	32.22	105.72	38.69	25.89	51.6
Paddy	12.0	14.59	14.59	15	15	15	15
Maize	3.58	6	6	54.5	51	51	62.4
Milk	2332	1320	1320	-	3500	3500	2000
Sale (qtls)							
Ragi	4.92	16	16	45.3	22.47	9.67	16.1
Paddy	-	4.59	4.59	-	-	-	-
Maize	-	-	-	47.5	45	45	56.4
Milk	1771	759	759	-	232	232	-

6.4 LARGE SYNTHETIC FARM

6.4.1 Plan 1.

Plan 1 elucidates the maximum possible profit from crop and dairy activities (Table 6.28). The levels of various activities in the farm plan and the possibility of non-plan activities entering the plan are discussed in the following paragraphs (constraints and problem matrix for large synthetic farm were presented in Appendix XI).

6.4.1.1 Crop Activities:

An area of 3.15 ha of kharif unirrigated land was kept for local variety ragi to supply 31.5 qtl of grain for home consumption. The selling activities of ragi in all the three seasons warranted a higher sale price Rs 95, 102 and 99 per qtl in kharif, rabi and summer seasons. Hence production of ragi was limited only for home requirement. Paddy crop had entered the optimum plan to meet the minimum home requirement constraints as well as for sale. An output of 14.81 qtl of paddy local variety from 0.452 ha kharif irrigated land for home consumption and 39 qtl improved variety in rabi from 1.16 ha was produced and the latter could be sold at Rs. 106/qtl. Maize crop had entered the plan only for home consumption as per the constraint. The kharif irrigated land of 0.71 ha yielded 7.5 qtl. Unirrigated kharif land of 2.45 ha allotted for horsegram would bring Rs. 3430 as profit to the farmer. Dry chilli -

Table 6.29: Optimum Farm Plan 1 and 2

Large Farm

Activities in the Plan	Unit of activity	Level of activities
REAL ACTIVITIES		
Crossbred cow milking (type 2)	Number	2
Crossbred Heifer	"	6
Hallikar cow milking (type 2)	"	4
Sale of cow milk, kharif	Kgs	669
Sale of cow milk, rabi	"	943
Sale of cow milk, summer	"	493
Ragi unirrigated, kharif	Hectare	3.15
Paddy, kharif	"	0.452
Paddy, rabi	"	1.16
Maize, kharif	"	0.71
Horsegram unirrigated, kharif	"	2.45
Chilli, rabi	"	1.6
Grapes	"	0.796
Green fodder - Napier	"	0.192
Labour hire period 3	Man days	9.01
Bullock hire period 1	Pair days	20.3
Capital borrowing, kharif	Rs.100's	147
Capital borrowing, rabi	"	128
Capital borrowing, summer	"	99.6
Sale of paddy, rabi	Quintals	39.0
DISPOSAL ACTIVITIES		
Labour period 1	Man days	11.29
" 2	"	100.39
" 4	"	229.98
" 5	"	51.57
" 6	"	160.05
Bullock labour 2	pair days	139.[illegible]
" 3	"	15.21
" 5	"	39.38
" 6	"	168.25
Ragi straw	qtls	10.43
Paddy straw	"	63.83
Maize khadibi	"	14.42

a commercial crop, had occupied 1.16 ha of rabi irrigated land contributing Rs. 8271 to profit. One of the horticultural crops, grapes had entered the plan as annual crop competing for land (0.796 ha) in all seasons and it fetched the maximum profit of Rs. 17273/year. Napier grass was cultivated as an intermediate activity entirely used for dairy enterprise occupying 0.192 ha of irrigated land in all seasons.

6.4.1.2 Dairy Activities:

Two crossbred cows (type 2) and 4 local cows (type 2) had entered the optimum plan producing 820 kgs of home requirements and 2105 kgs for sale. The sale was 669 kg, 943 kg and 493 kg in kharif, rabi and summer seasons respectively. In view of the attractive income generated by their sale, six crossbred heifers also entered the plan.

6.4.1.3 Disposal Activities in the Plan:

Though under existing technology, optimum plans 1 and 2 would utilize land to the maximum extent, left 32.64 per cent of labour and 70 per cent of bullock labour unutilized. Surplus stock of grain byproducts constituted of ragi straw (10.43 qtl) paddy straw (63.83 qtl) and maize khadibi (14.42 qtl).

6.4.1.4 Non-plan Activities:

The opportunity cost of non-plan activities under technology in vogue in the large farms are presented in Table 6.30. From a close look at Table 6.30 it is evident that most of the activities, whether crop or dairy, would start competing with the plan activities at profit levels much higher than those existing. The exceptions where the margin could be regarded near feasible are those of irrigated rabi ragi and the mixed crop of summer ragi, jowar and avarai (French bean) on irrigated land. As for dairy activities crossbred cow (type 1) had to increase its profit to Rs. 1575.9/year instead of Rs. 738 and dry crossbred cow Rs. 4505 instead of Rs. 2750/year. The profit level of buffalo type 2 had to be Rs. 1766 than at Rs. 561, dry buffaloes Rs. 1575 than Rs. 241 and buffalo heifer Rs. 1583 than at Rs. 703. Among milking animals, crossbred (type 1) seemed to be the next best choice. Though the level of real activities entering plans 1 and 2 were same, difference would be observed in the opportunity cost of non-plan activities. The opportunity cost of non-plan dairy activities were still higher than that in plan I as may be seen from Table 6.30. The profit levels have to be exhorbitantly high in the case of local cows (type 1) at Rs. 2113.4 heifers (Rs. 3618.9) and dry buffalo (Rs. 4474.9) and buffalo heifers (Rs. 2706.1) whereas it was Rs. 860.6, 981.4, 1575 and 1583 respectively in plan I. If sericulture had to enter the plan medium and large variety cocoon production should bring Rs. 647 and 11865 more than the existing profits.

6.4.1.5 Improvement over existing condition:

The plan would enable better utilization of land by increasing the cropping intensity to 155.43 per cent from the existing 129 per cent (Table 6.31). No alteration in labour and bullock utilization was envisaged. By reallocation of the available resources, the net profit would be increased to Rs. 52583/year, that is, to 6.65 times the prevailing profit level without additional resources.

6.4.2 Plan 3.

The attempt under plan 3 was to identify the profit potential with only crop cultivation adopting improved practices. The level of real and disposal activities to be persued under the plan are presented in Table 6.32.

6.4.2.1 Crop Activities:

A total of 253.71 qtls of ragi improved variety was produced on an area of 5.6 ha unirrigated and in kharif 1.71 ha and 1.77 ha of irrigated land in rabi and summer seasons respectively. After meeting home requirements of 31.5 qtl, only 115 qtls ragi were sold during kharif season at the prevailing rate of

Table 6.30: Opportunity cost of non-plan activities under existing technology of large farm conditions.

Name of non-plan activity	Existing price profit level	Profit/price of which activity will enter the optimum plan	
		I	II
	Rs	Rs	Rs
Crossbred cow dry	2750	4505	-
Hallikar dry	401	860.6	2113.4
Hallikar Heifer	200	981.4	3618.9
Buffalo dry	241	1575	4474.9
Buffalo Heifer	703	1583	2701.6
Sale of buffalo milk kharif	1.6	-	10.76
Kharif ragi (improved)unirrigated	690	5241	5241
Kharif ragi (improved) irrigated	2243	3623	3623
Kharif ragi with jowar and avarai(French bean)	498	602.98	602.98
Rabi ragi (improved)	2562	2704.06	2704.06
Summer ragi (improved)	1104	5690.4	-
Kharif paddy (improved)	3536	4435.5	4435.5
Summer paddy	2371	4064	4064
Jowar	282	1470	1470
Potato	1840	4766	4760
Ragi straw buying	40	5.6	5.6
Ragi sale kharif	25	117.13	117.13
Ragi sale summer	19	-	345.6
Paddy sale kharif	134	186.36	186.36
Maize sale kharif	129	555	555
Cocoon medium	18400	-	19046
Cocoon large	7280	-	19145

Table 6.31: Resource utilisation and net income under existing conditions and Optimum plans (Model I)

Large Synthetic Farm

Name of resource	Existing condition	Optimal Plans					
		1	2	3	4	5	6
A. Land							
i) Total cropped area	9.99	12.046	12.046	12.0367	14.482	13.07	13.322
ii) Cropping intensity	116.39	155.43	155.43	155.31	186.86	168.65	172.03
Improvement over existing percentage		393.04	39.05	38.92	70.47	52.26	55.64
B. Labour utilized (man days)	1127 (66.55)	1140 (67.36)	1140 (67.95)	843 (49.79)	952 (56.26)	1142 (67.47)	1205 (71.18)
C. Bullock labour utilized	126 (18.82)	147 (22.09)	147 (22.02)	294 (44.13)	250 (37.49)	247 (37.07)	250 (37.43)
D. Capital mobilized	30885	48374	47927	21245	22192	29163	34093
E. Net Income	7902	52583	53644	38851	43927	48878	50533
Proportion of net income from cattle marketing	8.48	38	38	-	-	-	-

Figures in parenthesis indicate percentage to total.

Table 6.32: Optimum Farm Plan 3
Large Synthetic Farm

Activities in the Plan	Unit activities	Level of activities
REAL ACTIVITIES		
Ragi kharif unirrigated	hectare	5.6
Ragi rabi irrigated	"	1.71
Ragi summer irrigated	"	1.77
Paddy kharif	"	0.375
Paddy rabi	"	0.375
Paddy summer	"	0.375
Maize kharif	"	1.77
Maize rabi	"	0.0617
Labour hire period 1	Man days	11.7
Bullock labour hire period 1	Pair days	50.2
Capital borrowing rabi	Rs. 100's	36.6
Capital borrowing summer	"	36.9
Sale of ragi kharif	Qtls	115
Sale of maize kharif	"	104
DISPOSAL ACTIVITIES		
Labour period 2	Man days	80.2
" 3	"	69.68
" 4	"	314.3
" 5	"	84.95
" 6	"	300.5
Bullock labour period 2	Pair days	81.1
" 3	"	5.15
" 4	"	134.5
" 5	"	10.17
" 6	"	141.57
Kharif capital	Rs.	7520
Ragi - rabi (for sale)	qtls	52.57
Ragi summer (for sale)	"	54.64

Rs. 99/qtl leaving 52.57 qtl in rabi and 54.64 qtl in summer seasons in disposal activity. There was a possibility of other ragi crop activities entering plan if kharif unirrigated crop could fetch Rs. 7136 which seemed to be a remote possibility and if kharif irrigated land could bring Rs. 3929/ha. which seemed to be the next best in alternative crop activity for ragi. However, existing kharif ragi activity on unirrigated land could be improved only if the price per quintal of ragi crop during kharif season would be doubled. In each season 0.375 ha. irrigated land was kept for paddy crop to meet family consumption requirements. The opportunity cost of paddy at Rs. 318.4 413.64 and 294.84 per qtl during kharif, rabi and summer seasons respectively as against Rs. 112/qtl in all seasons barred its entry in the plan (Table 6.37). Cultivation of improved variety of maize in kharif season could produce a surplus of 104 qtl for sale over and above home requirement. But rabi crop had to be limited to home requirement as it would be profitable only at Rs. 319/qtl rather than Rs. 129/qtls.

With the addition of activities, the plan envisaged hiring of 50.2 bullock pair days and 11.7 man-days of labour and capital borrowing of the order of Rs. 7350. However, the amount kept in kharif capital constraints, which was showed as unutilized Rs. 7520 could compensate for this. Other non-plan crop activities namely, horsegram, groundnut and sugarcane could enter only at much higher levels of profits than those considered in the plan (Table 6.33).

6.4.2.2 Improvement over previous plans:

By producing only crop, the plan could not improve the resource utilisation over the optimum plan with existing technology. For instance, labour unemployment was of the extent of 50 per cent and there was no change in the land utilization. Yet, compared to the existing situation, the net income would increase 4.92 times (Rs. 38851/year).

6.4.3 Plan 4.

Table 6.33 depicts the activities in mixed farming with crossbred cows under plan 4. When high yielding cows and buffaloes were earmarked as improved technology in dairying and were allowed to compete, only crossbred cow of 3500 kg/year entered the plan in the minimum possible number.

6.4.3.1 Crop Activities:

With the entry of dairy animal in the plan crop activities were curtailed to 4.73 ha. dry land in kharif, 0.14 and 1.46 ha. of irrigated land in rabi and summer. After retaining 31.5 qtl for home consumption, 48.4 qtls in kharif and 44.4 qtls in summer, were

Table 6.33: Optimum Farm Plan 4
Large Synthetic Farm

Activities in the Plan	Unit activities	Level of activities
REAL ACTIVITIES		
Crossbred cow (3500 kg/year)	Number	1
Ragi kharif unirrigated	hectare	4.73
Ragi rabi irrigated	"	0.14
Ragi summer irrigated	"	1.46
Paddy kharif	"	0.375
Paddy rabi	"	0.375
Paddy summer	"	0.375
Maize kharif	"	1.46
Maize rabi	"	1.32
Jowar	"	0.281
Green fodder - Napier	"	0.313
Soobabul	"	0.538
Labour hire period 1	Man days	11.3
Bullock labour hire period 1	Pair days	44.7
Sale of ragi kharif	Qtls	48.4
Sale of ragi summer	"	44.4
Sale of maize kharif	"	83.3
Sale of maize rabi	"	74.8
DISPOSAL ACTIVITIES		
Labour period 2	man days	80.7
" 3	"	75.59
" 4	"	282.2
" 5	"	85.09
" 6	"	298.9
Bullock labour period 2	pair days	83.9
" 3	"	24.05
" 4	"	155.4
" 5	"	11.43
" 6	"	142
Capital kharif	Rs.	5927
Capital rabi	"	9998
Straw	qtls	321.2

offered for sale at the prevailing price of Rs. 99. The area under paddy crop would be the same as in Plan 3. But the price demanded (shadow price) for entry in the market was Rs. 258, 252.8 and 182.60 in kharif, rabi and summer seasons respectively. Maize would occupy 2.78 ha of irrigated land in kharif and rabi yielding 165.6 qtl out of which 158.1 qtl was for sale. The inclusion of dairy activities with improved milch breeds necessitated the provision of nutritive fodder which was to be met from the internal resources of the large farms. Thus 0.313 ha was allotted for napier grass in all the three seasons. The second source was subabul trees which in addition to yielding fodder would utilise dry land in all seasons. An area of 0.589 ha land was alloted for this activity round the year. Yet another source of feed was jowar which would use 0.28 ha to fulfil the minimum requirement constraint inspite of being costly.

6.4.3.2 Dairy Activities:

Only 1 crossbred cow (3500 kg/year) was kept in the plan. This was necessitated by the integer value constraint for dairy animal which otherwise was less than 1 animal producing milk only for home requirement.

6.4.3.3 Added Activity:

This plan permitted hiring of 44.7 bullock pair days and 11.3 mandays, but no capital borrowing activity.

6.4.3.4 Improvement over existing plan and other optimum plan.

Improved methods of crop and dairy production showed, more intensive use of land, that is, to the extent of 186.06 per cent an increase of 4.65 per cent over existing condition and 24.85 per cent over plans 1 to 3. Labour employment was slightly higher than other plans but markedly less than the existing condition. Without sale of animals, this plan generated a net return of Rs. 43927, almost 5.56 times the existing level but less than optimum plans 1 and 2.

6.4.4 Plan 5.

Plan 5 as presented in Table 6.34 slightly improved the profit prospects with the entry of horticultural crops.

6.4.4.1 Crop Activities:

An area of 4.73 ha. unirrigated kharif land and 0.14 ha irrigated land in rabi and summer were the alternative plan for ragi cultivation for home requirement and 48.4 qtls of sale. Since irrigated

Table 6.34: Optimum Farm Plan 5
Large Synthetic Farm

Activities in the Plan		Unit activities	Level of activities
REAL ACTIVITIES			
Crossbred cow (3500 kg/year)		Number	1
Ragi unirrigated land kharif		hectare	4.73
Ragi rabi irrigated		"	0.14
Ragi summer irrigated		"	0.14
Paddy kharif		"	0.375
Paddy rabi		"	0.375
Paddy summer		"	0.375
Maize kharif		"	1.23
Maize rabi		"	0.865
Jowar		"	0.281
Carrot summer		"	1.32
Brinjal kharif		"	0.23
Potato rabi		"	0.426
Green fodder		"	0.313
Soobabul		"	0.538
Labour hire period		man days	17.9
Bullock labour hire period 1		pair days	44.7
Capital borrowing summer		Rs. 100's	62.1
Sale of ragi kharif		quintals	48.4
Sale of ragi rabi		"	44.4
Sale of maize kharif		"	69.2
Sale of maize rabi		"	49.9
DISPOSAL ACTIVITIES			
Labour period	2	man days	25.47
"	3	"	76.52
"	4	"	248.06
"	5	"	55.9
"	6	"	144.55
Bullock labour period	2	pair days	78.5
"	4	"	154
"	5	"	14.97
"	6	"	147.9
Straw		qtls	212

ragi crop had to compete, with the horticultural crop, there was an increase in shadow price for kharif, rabi and summer minimum constraints. Paddy crop was kept unchanged in this plan. However, there had been an increase in the shadow prices of paddy minimum requirement constraint of the order of Rs. 304.4/qtl in kharif, Rs. 301.5/qtls in rabi and Rs. 280.94/qtls in summer season. A marginal decrease of 0.655/ha. was observed for maize crop resulting in selling only 118.1 qtls in the year. Shadow price for the minimum constraint of maize amounted to Rs. 144.1/qtl in kharif and 145.1/qtl in rabi. The vegetable crops entering the feasible plan were potato, carrot and brinjal. While potato was alloted 0.426 ha in rabi, carrot and brinjal were alloted 1.32 ha and 0.23 ha respectively in summer and kharif seasons. Carrot could compete for land in summer only at profit levels of Rs. 9222/ha and 9130/ha.

Hiring of 44.2 bullock pair days, 17.9 man-days of human labour and borrowing summer capital of Rs. 6210 were allowed to make the plan optimum.

6.4.4.2 Improvement over the previous plans:

The significant advantage of plan 5, was that it increased net return to Rs. 48878. The utilization of land was only 168.65 per cent as compared to 186.86 per cent in plan 4 and labour employment was almost equal to the existing 67.47 per cent.

6.4.5 Plan 6.

The various activities formulated under Plan 6 are depicted in Table 6.35. In the reallocation of land to find an optimum solution, napier grass activity has been dropped. Ragi, paddy, soobabul and jowar were unaltered as to plan 5. Maize in kharif and rabi seasons was increased to 1.4/ha. and 1.04 ha respectively. As a result, maize sale also increased to 104.9 qtl in the year. There was marginal increase in the land alloted for potato in rabi (0.502 ha), carrot in summer (1.52 ha) and brinjal in kharif (0.256 ha) over the previous plan. Mulberry crop occupied 0.112 ha for rearing 500 eggs of silk worm.

6.4.5.1 Dairy Activity:

Dairy activity was confined to one crossbred cow as in the previous plan.

6.4.5.2 Added Activities:

The plan required additional resources to the extent of 44.3 bullock pair days, 62.1 mandays of labour and Rs. 7020 capital for summer.

6.4.5.3 Improvement over previous plans.

Plan 6 brought Rs. 50533 as net return from crop, dairy and sericulture activities adopting improved methods. Land utilization was 133.36 per cent and labour 71.10 per cent. This plan like plan 4 had

Table 6.35: Optimum Farm Plan 6
Large Synthetic Farm

Activities in the Plan	Unit activities	Level of activities
REAL ACTIVITIES		
Crossbred cow (3500 kg/year)	Number	1
Ragi on unirrigated land kharif	hectare	4.73
Ragi irrigated, rabi	"	0.14
Ragi irrigated, summer	"	0.14
Paddy, kharif	"	0.375
Paddy, rabi	"	0.375
Paddy, summer	"	0.375
Maize, kharif	"	1.41
Maize, rabi	"	1.05
Jowar	"	0.281
Carrot summer	"	0.52
Potato, rabi	"	0.502
Green fodder	"	0.313
Soobabul	"	0.538
Mulberry	"	0.112
Cocoon	1500 eggs	0.299
Labour hire period 1	Man days	42.3
Labour hire period 2	"	19.8
Bullock labour hire period 1	Pair days	44.3
Capital borrowing summer	Rs. 100's	70.2
Ragi selling, kharif	quintals	48.4
Maize selling, kharif	"	80.00
Maize selling, rabi	"	56.5
DISPOSAL ACTIVITIES		
Labour period 2	man days	6.68
" 3	"	71.43
" 4	"	233.43
" 5	"	50.18
" 6	"	126.12
Bullock labour period 2	pair days	78.22
" 3	"	23.39
" 4	"	153.87
" 5	"	14.91
" 6	"	147.52
Straw	qtls	219.55

struck a balanced utilization of existing resources to bring maximum net return.

6.4.6 Appraisal of alternative plans under Model I.

A farmer owning 5.6 ha of unirrigated land and 2.15 ha of irrigated land with an initial capital of Rs. 8834 and work force of 1692.05 mandays and 666.72 bullock pair days was operating under sub optimal plan under existing technology which was a mixture of both improved and traditional. The existing situation and the improvement that can be brought about by reallocation of resources and adoption of new technology as envisaged in plans 1 through 6 are presented in nutshell in Table 6.36.

Plan 1 and 2 had optimum levels with existing technology alternatively excluding and incorporating silk worm rearing. Cropping intensity had increased to 155.43 per cent in both the plans. Not much difference was noticed in these two plans in terms of utilization of limited resources and efficiency in terms of profit maximization. Dairy was prospering in these two plans only because of the market value attached to the dairy animals (about 38 per cent of the total income in plan 1 and 2 was accrued from sale of animals).

Plan 3 was tested only for the efficiency of improved crop technology in bringing maximum profit. This could generate better gross margin (Rs. 38851) than

Table 6.36: Comparision of optimum plan 1 to 6 in terms of important production pattern - Large farm.

Particulars	Existing plan	Optimum Plan					
		Existing Technology			Improved Technology		
		1	2	3	4	5	6
PRODUCTION (qtls)							
Ragi	172.91	31.5	31.5	253.7	124.3	79.9	79.9
Paddy	33.05	53.81	53.81	15.0	15.0	15.0	15.0
Maize	14.81	7.5	7.5	111.5	165.6	125.6	112.6
Milk (kg)	5115	2925	2925	-	3500	3500	3500
SALE (qtls)							
Ragi	141.41	-	-	115	92.8	48.4	-
Paddy	18.24	39	39	-	-	-	-
Maize	7.31	-	-	104	158.1	118.1	104.9
Milk (kg)	4296	2195	2195	-	-	-	-

the previous 2 plans under existing technology (Rs 7564). The quantum of borrowed capital was almost 5 times in plan 1 and 2 than in plan 3.

Plan 4 did not show any prosperity to dairy activity though it was meant to be the alternative plan with high yielding dairy animal. The obvious reason being that high yielding animals were kept only for milk production. Yet, land utilization was maximum (186.86 per cent) due to fodder cultivation even on unirrigated land. There was no borrowed finance. The activities in the plan would generate sufficient income to mobilize the resources and bring a net profit of Rs. 43927/year. If dairy animals were given the chance of being brought to market it could result in better returns.

Though plan 5 and 6 having improved horticultural crop and cocoon production, as plan alternative, brought higher margin (Rs. 48878 and 50533 respectively) the stringent land resource was less utilized than in plan 4. The cropping intensity for plan 5 was 168.65 and for plan 6 it was 172.83.

Judged by the two most limiting constraints of land and capital, plan 4 improved crop and dairy activities [illegible] can be regarded the best among plans, followed by plan 6 and plan 5 in model I. However, Model I assumed certainty in gross margin which would

Table 6.37: Opportunity cost of non-plan activities at improved technology - Large farm

Name of plan (non) activity	Profit/price considered in the Plan	Profit/price at which activity enter the optimum plan			
		3	4	5	6
Crossbred cow 2000 kg/year	1774	-	12292	14318	2652
" 2500 kg/year	2282	-	10587	12047	3974
" 3000 kg/year	2909	-	7799	-	4600
" 3500 kg/year	3478	-	-	-	8478
Crossbred Heifer	400	-	29517	34989	4533
Buffalo 2000 kg/year	2052	-	-	-	2119
Sale of cow milk kharif	1.55		6.92	7.94	1.85
Sale of cow milk rabi	1.55	-	-	1.95	-
Ragi (single crop) improved unirrigated	715	2000	729	730	730
Ragi improved irrigated	4588	11173	6546	7122	7122
Groundnut unirrigated, kharif	932	2649	2649	2770	2770
Horsegram unirrigated, kharif	519	2119	2119	2137	2137
Sugar cane	13029	18552	21918	27591	27591
Carrot, kharif	8549	-	-	9222	9222
Carrot, rabi	8549	-	-	9131	9131
Brinjal, kharif	9295	-	-	-	-
Potato, rabi	9806	-	-	-	-
Cucumber, kharif	5679	-	-	9454	9454
Sale of ragi (rabi season)	99	184	157	176	176
Sale of ragi (summer season)	99	184	-	155.9	155.9
Sale of paddy, kharif	112	318	258	-	-
Sale of paddy, rabi	112	414	253	286	269
Sale of paddy, summer	112	295	183	165	265
Sale of maize	129	319	-	-	-

never be the reality. Hence Model II was brought out for these plans 1 to 6, with the exception of plan 5 with uncertain gross margin for cereal, cash crop, dairy animal and silk worm rearing.

6.5 MARGINAL VALUE PRODUCTS/SHADOW PRICES OF LIMITED RESOURCES BY PLANS UNDER MODEL I

It is normally believed that when market prices are distorted or fluctuating, especially in developing areas, shadow pricing is taken as guideline for any public investment project (Warn, 1982).40/ Shadow prices are the opportunity costs of the factors and are crucial indicators for the expansion of the farm. Greater emphasis is being given to land development and water and irrigation resources management in dry farming area of Bangalore district to increase the productive capacity of soil and thereby improve the economic conditions of dry land farmers. Along with optimum plans, the marginal value product (MVP) of scarce resources would provide empirical support for planning prospective uses of existing resources in dry land farming area. This would also provide guidance, along with cost of production, the price level expected for those produce which serve dual purpose of family

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40/ Peter, G.Warr (1982) Shadow pricing rules for non traded commodities. Oxford Economic Papers, Vol.34, No.2, July. pp. 305-325.

consumption and market supply for various farm situations. Marginal value products for each plan under different farm conditions exhibited variation. The shadow prices of limited constrained resources under various plan situations of Model I are put out in Table 6.35.

6.5.1 Existing Technology.

Plan 1 and 2 for all the farm situations had brought same MVP since only marginal differences in the optimal activities were observed. Hence the results are discussed under one hearing (Table 6.35).

6.5.1.1 Land:

Increase of one hectare of land, kharif irrigated, would add Rs. 5077 to net income to marginal farms, Rs. 6081 to small farms, Rs. 3111 for medium farmer and Rs. 5817 for large farmer. Kharif unirrigated land would add a net profit of Rs. 855, 761, 488 and 1123 to marginal, small, medium and large farms with an increase of one hectare. A unit increase in rabi irrigated land in the four categories of farms could increase the profit to Rs. 3520, 9049, 3593 and 4531 in that order. Summer irrigated land could not bring any addition to small and marginal farms since unutilized land was shown in the plan. But, for medium and large farms the addition of one unit of land would mean a gain of Rs. 6504 and 5494 respectively. Thus it is seen that

Table 6.35: Marginal value products/shadow prices of limiting resources/conditions in various plans in Model I for various farm situation

Name of limiting resources/condition	Plan 1 and 2 Marginal farm	Small farm	Medium farm	Large farm	Plan 3 Marginal farm	Small farm	Medium farm	Large farm
Land kharif-I	5077	5081	3110.6	5817	9697	3596	9697	8365
" VI	855.16	761	487.9	1123	1762	1696	1762	1566
" Rabi-I	3520	9049	4531	3597	5163	2553	5705	5705
" Summer-I	-	-	5493.3	5504	1968	2553	2378	2378
Labour period 1 (man days)	0	0	9.12	0	0	0	0	3.0
" 2	0	0	0	0	0	0	0	0
" 3	0	0	0	9.12	0	0	0	0
" 4	0	0	0	0	0	0	0	0
" 5	0	9.2	0	0	0	0	0	0
" 6	0	0	0	0	0	0	0	0
Bullock labour period 1	22.8	22.8	22.8	22.8	21.94	0	0	20
" 2	0	0	0	0	0	0	0	0
" 3	22.8	0	0	0	22.8	0	0	0
" 4	0	0	0	0	0	0	0	0
" 5	8.69	0	0	0	22.8	0	0	0
" 6	0	0	0	0	0	0	0	0
Capital season 1 (M)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.0
" 2	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
" 3	0.14	0.14	0.14	0.14	0.14	0.14	0.18	0.14
Space (sq.metre)	0	436.57	0	0	0	0	0	0
Green fodder	54.52	225.75	56.92	265.9	0	0	0	0
Ragi straw	0	0	0	0	0	0	0	0
Paddy straw	0	0	0	0	0	0	0	0
Maize khadibi	0	0	0	0	0	0	0	0
Milk (cow) season 1	7.56	1.63	1.63	1.63	0	0	0	0
" 2	2.85	1.64	1.79	1.78	0	0	0	0
" 3	2.85	1.82	4.98	1.82	0	0	0	0
Buffalo milk season 1	1.32	1.82	1.52	1.82	0	0	0	0
" 2	2.17	2.17	2.17	2.17	0	0	0	0
" 3	2.28	2.28	2.26	2.28	0	0	0	0
Ragi season 1	108.3	108.3	108.3	130.4	99	99	99	99
" 2	-	116.3	275.5	116.28	0	0	0	0
" 3	-	112.85	395.6	112.80	0	0	0	0
Paddy season 1	152.76	226.95	345.5	205.1	164.6	294	364.6	318.4
" 2	120.34	120.84	120.84	120.84	197.37	63.80	196	196
" 3	127.58	127.68	127.7	127.7	97.80	63.35	97.2	77.2
Maize 1	271.57	319.5	159.7	571	145	129	147.3	1.29
" 2	-	171	276	[illegible]	75.03	25.5	77.32	0
Number of cow	0	754	464	362.5	[illegible]			0
Number of buffaloes	[illegible]		[illegible]	[illegible]				

Name of limiting resources/condition		Plan 4				Plan 5				Plan 6			
		Marginal farm	Small farm	Medium farm	Large farm	Marginal farm	Small farm	Medium farm	Large farm	Marginal farm	Small farm	Medium farm	Large farm
Land	1	854.2	854.2	7596	7365	8556	8556	8556	9129	8322	8327	8221	9129
	2	1639	1639	1696	1376	1639	1639	1639	1503	1516	1519	1527	1503
	3	8542	8823	7843	7843	8542	8823	8823	8717	8542	8823	8717	8717
	4	6791	6170	5879	5879	7745	8083	8083	8027	7745	8082	8083	8083
Labour	1				0				8.24	7.5	7.38	7.52	9.34
	2				0								
	3				0								
	4				0								
	5				0								
	6				0								
Bullock labour	1	22.8	22.8	20	20		22.8		22.34	22.8	0	22.8	22.34
	2				0						0		
	3	22.8			0					22.8	0		
	4				0						0		
	5	22.8			0	22.8		22.8		22.8	0		
	6				0						0		
Capital	1	0.14	0.14	0.14	0	0.14	0.14	0.14	0.117	0.14	0.1398	0.125	0.117
	2	0.14	0.14	0.14	0	0.14	0.14	0.14	0.125	0.14	0.1398	0.125	0.125
	3	0.14	0.14	0.14	0	0.14	0.14	0.14	0.14	0.14	0.1398	0.14	0.14
Space		0	0	0	0	0	0	0	0	0	0	0	0
Green fodder		333.3	342.7	310	308.48	360.9	370	369.57	363.8	47.42	49.81	47.72	48.38
Ragi straw		0	0	0	0				0			0	0
Paddy straw		0	0	0	0				0			0	0
Maize khadihi		0	0	0	0				0			0	0
Milk (cow)	1	5.71	5.89	5.32	5.32	0	6.41	6.4	6.3	2.11	2.89	3.01	2.42
	2	2.11	2.11	1.85	1.85	2.11	2.1	2.11	2.00	2.47	2.14	2.38	2.08
	3	2.11	2.11	1.85	1.85	0	2.11	2.11	2.11	2.11	2.11	2.08	2.10
Buffalo	1	2.11	2.11	2.15	2.5	2.11	2.11	2.11	2.79	2.11	2.11	2.1	2.79
	2	1.77	1.77	1.55	1.55	1.77	1.77	1.77	2.15		1.77	2.01	1.75
	3	1.77	1.77	1.55	1.90	1.78	1.77	1.77	1.77	1.77	1.77	1.74	1.77
Ragi	1	112.86	112.9	99	99	112.86	113	112.8	110.5	112.06	112.84	111.3	110.6
	2	199.57	191.8	157	157	199.57	192	191.8	188.1	199.56	191.81	188.1	188.1
	3	117.86	117.86	99	99	171.31	169.7	169.77	169.8	171.3	169.77	169.77	169.8
Paddy	1	313.5	311.6	258	258	314.13	314	314	304.4	313.47		307.4	304
	2	319.53	307.4	251	252	318.53	307	307	301.5	318.53		301.5	302
	3	233.23	541.9	182.56	187.66	-	281	280.94	280.94	303.38		280.9	281
Maize	1	147	147	129	129	147	147	147	144	147	147	145	144
	2	147	147	129	1.26	147	147	147	145	147	147	145	145
Number of cow			0	0	0	*	0	0	0	0			0
Number of buffalo		14131	14596	13912	13912	15505	15936	15936	16624	917.88			1118
Mulberry leaf			0	0	0	0	0	0	0	42.74		43.62	43.11
Sonbabul		139.66	135.66	135.8	135.76	13[illegible].6	139.66	139.66	138.14	139.6		138.63	138.14
Jowar		221	221	213.7	211.5	221	221	221	217.1	219		217.9	217.14

under existing technology MVP for land differs with farm type depending on the choice of production which it was put to. Contrary to earlier findings (Saini, 1982) no increasing or decreasing value among farm and among season was observed.

6.5.1.2 Labour:

Human labour in general is not scarce for all farm situations except for medium farms during kharif peak season, large farms during rabi peak season and small farms during summer peak season. The MVP of labour for these farm situations was Rs. 9.12, 9.12 and 9.20 respectively while the market rate considered was Rs. 8.00

6.5.1.3 Bullock labour:

The MVP for bullock labour for all the farm situations during kharif peak was Rs. 22.8 and for marginal farmer during rabi peak season and summer peak season it was Rs. 22.8 and 8.69 respectively. Other farm situations had unutilised bullock labour during these periods. Hence MVP for bullock labour was zero.

6.5.1.4 Capital:

There was no change in the interest on capital borrowing and MVP for capital in all the farm situations. Fourteen per cent was the interest rate for capital in all seasons except under plan 6 for medium far at 12.5 per cent and large, 11.7 per cent and 12.5 per cent for kharif and rabi season.

6.5.1.5 Space:

Space for livestock was constraint only for farmer. Its shadow price was Rs. 436.57/sq.metre.

6.5.1.6 Green fodder for Bovines:

Green fodder for bovines was kept as minimum constraint which was met by cultivation napier grass on irrigated land. One quintal increase in this minimum constraint would cost Rs. 54.62 for marginal farmer, Rs. 225.75 for small farmer, Rs. 56.92 for medium and Rs. 265.9 for large farmer.

6.5.1.7 Milk:

Cow milk constraints were kept as more than or equal to consumption requirements. Shadow prices for this constraint also differed among farm situations. For marginal farmer shadow price per kg of cow milk was Rs. 2.66 during kharif season and Rs. 2.85 in rabi and summer seasons. For other farm situations it was Rs. 1.63 in kharif and Rs. 1.78 in rabi except for small farms (Rs. 3.64) and during summer season it was Rs. 1.82 for small and large farm and for medium farms it was Rs. 4.98. In general, marginal farm had higher shadow price for this constraint because only local cow entered the production plan under existing condition for milk supply (465 kg/year) for family and sale (Table 6.1).

Buffalo milk was kept at a minimum constraint more than or equal to zero. The shadow price/kg of buffalo milk for kharif, rabi and summer was Rs. 1.82, 2.17 and 2.28 respectively. The difference between market price and shadow price were 0.22, 0.27 and 0.28 for the respective seasons. While seasonal variation of a definite order was observed in buffalo milk price for all farm situation no such trend was noticed in the case of price of cow milk.

6.5.1.8 Ragi:

Minimum constraint of ragi had also price difference among seasons. For marginal, small and medium the kharif ragi had a shadow price of 108.3/qtl, and for large farmer it was Rs. 130.4/qtls. Rabi and summer shadow prices were Rs. 116.3 and 112.85 respectively for small and large farmer. Medium farmer had different shadow prices for rabi ragi constraint (Rs. 275.6) and summer ragi constraint (Rs. 395.6).

6.5.1.9 Paddy:

Kharif paddy constraint had for marginal farmer a shadow price of Rs. 152.76, for small farmer Rs. 226.95, for medium Rs. 345.5 and for large farmer Rs. 205.1/qtl. For rabi and summer constraint of paddy it was Rs. 120.84 and 127.68/qtl. respectively for all the farm groups.

6.5.1.10 Maize:

Minimum maize constraint had Rs. 273.57, 319.5, 159.7 and 573 as shadow price for marginal, small, medium and large farmers during kharif season. During rabi season marginal farmer, and large farmer did not cultivate the crop. For small and medium farmer the shadow prices were Rs. 171 and 296 respectively.

6.5.1.11 Number of cow and number of buffalo constraint were kept only to avoid heifers which had a tendency to enter the plan by virtue of the higher market value than adult animals. Hence shadow prices for these two constraints were inconclusive but a decreasing MVP for increasing size of herd has been observed in the past (Roquel, 1975).41/ In general, under existing technology a unit increase in irrigated land for marginal and small farms could bring Rs. 3520 to 5077 and Rs. 6081 to 9049 increase in net income. Considering the optimal solution, this increase through relaxing land constraint would be remarkable improvement in the condition of marginal and small farmers.

41/ Roquel, M.M. (1975) Analysis of the Economic alternatives for the large size dairy farms in Wisconsin Agriculture. Ph.D. Thesis, unpublished, University of Wisconsin, USA, 1-12.

Similarly any step to improve cow milk production would bring more benefit to marginal farmer than any other category. Whereas for large farmer's return could be increased by improvement in ragi and maize production over the existing levels, medium farmer's hope was in improving paddy fields and ragi in rabi and summer seasons.

6.5.2 Improved Technology.

Improved technology had enhanced land value in all the farm situations. Since plan 3 to 6 consisted of same input output matrix and only 'b' vector was parameterised for each farm situation, in general, there was no difference in the shadow prices for land among farms. But among plans, the shadow prices differed according to the type of activities that entered the plan.

In plan 3, shadow prices for kharif irrigated land were Rs. 9697 for marginal and medium farms, Rs. 8596 for small farms and Rs. 8365 for large farms. Kharif unirrigated land had Rs. 1762 and 1696 for marginal and medium farms and Rs. 1566 for small and large farms respectively. Rabi irrigated land had Rs. 5163, 2553 for marginal, small and Rs. 5705 for the other two farm categories respectively. Summer irrigated land had Rs. 1988, 2553, 2378 for the marginal small and medium and large farms. Plan 4,5 and 6 uniformly had lesser MVP for kharif irrigated land between 7596 to 8542/ha. as against Rs. 8365 to 9667 in plan 3. Kharif unirrigated land had MVP ranging between Rs. 1376 to 1639.

Rabi irrigated land had much higher shadow prices because of its utilization by fodder crop, and mulberry (Plan 6). MVP for this land constraint ranged between Rs. 7843 to 8823.

Similarly summer land constraint had MVP ranging between Rs. 5879 to 8083/ha. Improved technology had the advantage of increasing the productivity of land in rabi and summer seasons, more then even kharif season. Hence every step towards improvement of water resource management would be beneficial to all types of farmers in dry farming area.

6.5.2.1 Milk:

In all the plans with dairy activity, the shadow prices for cow milk were higher than that for buffalo milk. This is due to the high yielding crossbred cow which needs both unirrigated and irrigated land to meet the fodder and feed requirements over and above the purchased least cost ration. This situation was brought at par with shadow price for buffalo milk constraint in plan 6 where mulberry had dual purpose of feeding silk worm and crossbred cows. In plan 4 kharif milk sale had a shadow price of Rs. 5.71, 5.89

for marginal and small and Rs. 5.32 for other farm groups respectively. In plan 6 it was Rs. 6.4 for all categories, except marginal where surplus milk was shown as stock. Plan 6 had Rs. 2.11, 2.89, 3.01 and 2.42 as shadow price for marginal, small, medium and large farms.

Rabi and summer constraints had almost the same shadow prices for all categories of farms, namely Rs. 2.11 or 1.85. Buffalo milk had Rs. 2.11, 1.77 as shadow price for kharif and other seasons respectively for all farm groups in all the three plans.

6.5.2.3 Ragi:

There was no noticeable difference in the shadow price of ragi among farms or between plans. In general kharif ragi mostly cultivated on unirrigated land had lower shadow price of Rs. 99 to 113/qtl. than rabi ragi which ranged between Rs. 188 to 199/qtls and summer ragi between Rs. 99 to 171/qtls.

6.5.2.4 Paddy:

Kharif and rabi paddy were costlier than summer paddy. Kharif paddy had shadow prices ranging between Rs. 258 to 314 and rabi between Rs. 252 to 318, whereas, summer paddy had a range of Rs. 182 to 281 with the exception of small farmer in plan 4 who had Rs. 542 as shadow price for this season.

6.5.2.5 Maize:

Maize did not have differential shadow price for the seasons. In general, it ranged between Rs. 126 and 147/qtl.

6.5.2.6 Soobabul and Jowar:

These two crops, though meant to feed the high yielding cattle by producing fodder and grain on unirrigated area, in practice, when it had to compete with other crops and activities, costed much more than expected. Shadow price for soobabul was Rs. 139.66 and for jowar it was Rs. 221 for every quintal increase in the constraint.

6.5.2.7 Space for Animal and dry fodder:

Optimum plans 4 to 6 had surplus of roughage production and excess of space for animal. Owing to this, the MVP for space and dry fodder constraints became zero. Since the problem matrix, both under existing and improved technology consisted of dairy animals only excess space could not be tested for utilization by other livestock such as goat, sheep etcetra. Also enrichment of poor quality roughage with small quantities of complementary items such as bran, urea, molasses and salt could augment the source of cattle feed[42] for high yielding animals.

42/ Vijayalakshmi, S. and S.R.Sampath (1978) Feed needs of bovines in dry farming areas in Karnataka. Mysore. J.agric.Sci., 12: 594-597.

In conclusion the following observations could be made. Land improvement for dry farming area, by and large, bring multifold benefits to the farming community, be it under existing condition or improved. Labour in this area is surplus. Such of the farm activity, for example processing of the farm produce, or other cottage industries which do not need land could employ the surplus farm labour. Farm produce milk, paddy, ragi and maize, which have dual purpose, namely have consumption and market sale demand prices higher than the existing levels.

6.6 EXTENT OF CAPITAL BORROWING UNDER MODEL I

Capital comes next only to land as a critical input in farming. Capital available at the disposal of farmer can be taken an epitome of all inputs. The unabated issue on capital or credit at planning level centres around two important aspects, namely, inadequacy of capital and untimely credit supply to the farmers. On the other hand, what is provided to farmers by financial institution is doubted for its utilization. This sort of dichotomy in the situation calls for deeper probe under optimum condition.

Available empirical evidence indicates that farmers had to depend on borrowed funds especially when improved levels of technology was adopted (Johl and Kahlon, 1967; Chauan and Johl, 1967; Sirohi and

Gangwar, 1968; Singh, 1970; Kahlon *et al.*, 1975; Sirohi *et al.*, 1980; Gill, 1982). A proper assessment of capital requirements at existing technology and recommended levels of technology is, undesirably, a prerequisite for the implementation of the optimum plans.

Table 6.36 portrays the extent of borrowing under each optimum plan for each farm condition. The following observations, in general, can be made from the Table 6.36.

1. Optimum plans 1 and 2 under existing technology in all the farm situations demanded more capital than other plans which were formulated under improved technology.

2. Uniformly, it was observed that under improved technology plan 4, namely crop and dairy needed less borrowed capital than plan 3, 5 or 6

3. Credit supplied during kharif season mostly benefits the farmer to move towards optimum plans, be it under existing or improved except for medium and large farm in which case there was no singular trend during any particular season.

4. Minimum land holding which could absorb all the credit need to be studied in view of excess borrowing as shown under marginal farm.

Table 6.39: Extent of capital borrowing in different seasons and the total working capital in the plans (Model I).

Category of farm	Optimum Plan	Amount borrowed during			Total amount borrowed	Total working capital
		Kharif	Rabi	Summer		
		Rs	Rs	Rs	Rs	Rs
Marginal	1	6670	124	1010	7805	4749
	2	6670	124	1010	7805	4749
	3	4760	754	775	6299	4000
	4	5770	-	351	6120	4082
	5	-	7540	1070	8610	4832
	6	-	-	7170	7170	3883
Small	1	8640	-	2390	10030	11030
	2	8640	-	2390	10030	11030
	3	-	6890	993	7883	6195
	4	6890	335	566	7791	5676
	5	-	8850	1060	9910	5982
	6	-	-	-	-	6350
Medium	1	-	1630	14600	15900	16680
	2	-	1630	14600	15900	16680
	3	-	4140	1780	5920	9165
	4	-	-	3750	3750	10525
	5	3990	-	1810	5800	11343
	6	-	5630	3840	9470	17210
Large	1	14700	12800	9960	37460	48374
	2	14700	12800	9960	37460	47927
	3	-	3660	3690	7350	21245
	4	-	-	-	-	22192
	5	-	-	6210	6210	29163
	6	-	-	7020	7020	34093

CHAPTER - 7

INSTABILITY IN FARM ECONOMY

INSTABILITY IN FARM ECONOMY

Physical variability, an exogenous change, is more important in crop and livestock production and is concentrated in those area where weather is unstable. The zenith of uncertainty is found in farm commodity prices also. Historically, farm prices have been highly unstable and great fluctuation have taken place from year to year. The pattern of production in one year, therefore, often deviates widely from that which would give the most profitable or efficient use of resources. Accordingly area under crop is changed and to some extent the number of livestock unit is also changed. Farmers, usually take several precautions against crop failures by adopting cost flexibility. In short, concatenated with unstable or unpredictable rain fall, there are multiplicity of causes which interact simultaneously to affect the net return from farm production.

This chapter deals with measuring the variability in major factors responsible for instability in farm economy namely area, yield, product prices and net return per unit of production by coefficient of variation figures. After examining the variability figures the significant changes taken place in the disturbing factors over eleven years were brought out by fitting trend. Percentage deviation from mean values of disturbing factors as well as production and net return from each farm activity was pictured by graphical representation. Finally the data were also processed for the interelationship between each factors and between net return of various enterprises.

7.1 INSTABILITY IN CROP YIELD, PRODUCT PRICES AND GROSS MARGIN

Table 7.1 presents the coefficient of variation (CV) in crop yield, product prices and net return per hectare of selected crops. It is evident from Table 7.1 that the CV of yield was highest in chillies (95.67 per cent) followed by potato (35.73 per cent) and ragi (34.17 per cent) The least variation was noticed in the case of maize (10.39 per cent).

Further, it was observed from the table that area under jowar cultivation was varied to a large extent. The CV for area under jowar was 149.7 per cent. Area under most of the other crops registered comparatively less variation. This indicates that farmers in Bangalore district who face almost 58 per cent variation in rain-fall (Appendix XII) almost followed a fixed cropping pattern.

Moving further down in the table, it can be seen that the CV of product prices of sugarcane recorded highest percentage (40.95). This was followed by maize (30.27) and groundnut (29.92). The smallest CV was computed for potato.

Table 7.1: Coefficient of variation of Area, Yield, Product price and gross margin of selected crops and correlation coefficient between disturbing factors of farm economy in Bangalore District.

(1969-70 to 1979-80)

Sources of variation in Farm Economy	Paddy Mean/ r value	Paddy C.V.	Ragi Mean/ r.value	Ragi C.V.	Maize Mean/ r.value	Maize C.V.	Jowar Mean/ r.value	Jowar C.V.	Horsegram Mean/ r.value	Horsegram C.V.	Dry chilly Mean/ r.value	Dry chilly C.V.	Groundnut Mean/ r.value	Groundnut C.V.	Sugarcane Mean/ r.value	Sugarcane C.V.	Potato Mean/ r.value	Potato C.V.
Area under cultivation (ha)	35388	15.29	218517	5.26	12403	-38.63	370.16	149.75	33130	13.55	2505	6.66	16806	22.4	4324	14.05	671	30.22
Yield per hectare (ctls)	18.63	23.97	11.10	34.17	36.83	10.39	23.10	31.70	4.46	25.76	2.87	95.67	8.32	15.59	791.18	17.84	150.64	35.73
Price per ctl(Rs)	102.39	26.49	102.47	26.35	91.03	30.27	91.65	25.40	100.16	25.97	535.7	37.60	190.59	29.72	153.16	40.95	93.06	18.63
Cost of production per ha.(Rs)	1195		798		1017		715		332		1103		378		3407		3824	
Gross return per hectare(Rs)	1934	37.11	1143	42.39	3285	24.98	2144	43.87	459	36.89	1837	39.07	1563	28.92	11689	29.44	14535	49.8
Net return per hectare (Rs)	739	56.38	345	70.22	2268	27.85	1429	56.27	127	68.3	735	50.4	1185	26.3	8282	31.46	10711	50.4
Area-yield correlation	0.3501		0.3671		-0.5530		-0.4646		0.4833		-0.2405		-0.0068		-0.5904		0.4969	
Area-price correlation	-0.3770		0.6414		0.0180		-0.3520		0.8293		-0.4898		0.2689		0.5200		0.1611	
Price-yield correlation	0.7340		0.0679		-0.694		0.1663		0.4729		0.1914		-0.3297		-0.3290		0.6090	
Area-net return correlation	0.0435		-0.0207		-0.1370		-0.5043		0.7500		-0.5244		0.3206		0.2990		0.4695	
Yield-net return correlation	[illegible]		0.8520		-0.5032		0.740		0.8078		0.4373		0.1964		-0.0660		0.9530	
Price-net return correlation	[illegible]		[illegible]		0.9681		0.768		0.8919		0.2659		0.0490		0.068		0.9670	

Examination of gross return per hectare pointed out that variability was highest in the case of potato (CV = 44.8 per cent) followed by ragi (42.39 per cent). The least variability was observed in the case of maize (24.98 per cent) followed by groundnut (28.92 per cent).

Taking cost of production into consideration the least expensive production was horsegram which recorded on average Rs. 332 per hectare. This was followed by groundnut which costed Rs. 378 per hectare. The costly crop was potato and sugarcane. However, when cost of production per hectare was considered for deriving net return per hectare the variability figure reached maximum for ragi crop (78.22 per cent) followed by horsegram (68.3 per cent). These two crops, are usually dry land crop raised mostly during kharif season. The minimum variation was noticed in the case of groundnut (26.3 per cent) followed by maize (27.86 per cent).

Gross margin per hectare depends not only on the individual factors such as area, yield, price and cost of production, but also the correlation between these factors. A positive correlation between two factors implies that the two tend to fluctuate together. The area-yield; yield-price; area-price, net return and area; net return and yield; and net return and price correlations are reported in Table 7.1. Except for paddy, ragi, horsegram and potato, the area-yield correlation become negative for all the other crop, though found significant only in the case of sugarcane and maize. The price-area correlation for ragi, horsegram and sugarcane was positive while in other crop this correlation was found negative or insignificant. This apparently speaks of the positive influence of price in farmers allotment of land for ragi, horsegram or sugarcane.

Price and yield correlation suggests that except in the case of maize and potato which had negative correlation (-0.694) and positive correlation (0.609) respectively, yield per hectare of other crops had no significant correlation. Moreover, net return per hectare and price of produce and net return and yield per hectare were found significantly correlated for almost all the crops except in the case of sugarcane and groundnut and maize.

In short the following inferences were drawn from the table: (i) Food crops did not vary much in area over the study period; (ii) horticultural crops such as chilli, potato had undergone maximum fluctuation in the productivity/hectare; (iii) annual crop (sugarcane) had faced maximum price variability; (iv) net return from staple food crops namely ragi, paddy and jowar had shown maximum variability; and (v) farm product price seemed to have no correlation with yield but significantly related with area under ragi and horsegram.

7.2 TREND IN THE FACTORS CAUSING INSTABILITY IN GROSS MARGIN

Table 7.2 brings out the significant changes during the 11 years with regard to the some of the important factors deciding the level of gross margin from crop production.

From the Table 7.2 it is observed that farm commodity prices had significant increasing trend for all the farm enterprises. Further, significant decreasing trend is noticed in yield/hectareof maize and sugarcane production. Interestingly, significant decrease in the area under dry chilli and significant increase in the area under potato are observed from the table.

Figures 1 to 16 (Appendix XII) picture the extent of fluctuation in the disturbing factors of gross margin for various crops. It is clear from the picture that gross margin per hectare which is dependent on fourfold factors, namely area, yield, price and cost oscilated to a greater extent than any one single factors.

7.3 INSTABILITY IN MILK PRODUCTION, PRICES AND NET RETURN PER ANIMAL

The estimated milch population-crossbred cow, local cow, and buffalo, and population estimates of milk production over 11 years are set out in Table 7.3. A perusal of Table 7.3 points out that the significant,

Table 7.2: Trend values - in Area, Yield and Prices of produce.

Particulars	Paddy			Ragi			Maize		
	Area ha	Yield ha	Price/ qtl	Area ha	Yield ha	Price/ qtl	Area ha	Yield ha	Price/ qtl
1	2	3	4	5	6	7	8	9	10
Trend value (b)	981.4	0.5305	5.35	509.29	0.8521	4.0897	823.86	0.915	4.119
S.E. of b	464.6	0.4125	2.06	1142.96	0.2544	2.3467	395.7	0.234	2.406
t value of b	2.11	1.2861	2.60	0.445	3.3493	1.7432	2.08	3.911	1.763
Intercept (a)	4.275	15.45	70.29	215461	5.9829	77.93	7459.8	42.33	66.32
S.E. of a	1540.9	1.3682	6.83	3790.8	0.8438	8.77	1312.6	0.776	7.976
r^2	0.331	0.1552	0.422	0.0216	0.5548	0.2524	0.325	0.629	0.2459
F.value	4.46	1.65	6.74	0.2	11.22	3.04	4.33	15.29	2.93
	Jowar			Horsegram			Groundnut		
Trend value(b)	-91.28	0.2309	3.54	711.75	0.176	6.55	433.75	-0.12	12.33
S.E. of b	46.66	0.7319	2.02	459.6	0.1186	1.96	331.88	0.12	3.99
t value of b	1.956	0.3264	1.75	1.55	1.49	3.34	1.31	0.94	3.088
Intercept (a)	917.86	24.82	70.43	29215	3.48	64.11	13484	9.04	116.58
S.E. of a	154.7	2.43	6.71	1398.4	0.361	5.97	1100.7	0.41	13.24
r^2	0.298	0.0117	0.25	0.48	0.217	0.58	0.1595	0.09	0.55
F.value	3.83	0.11	3.05	2.4	2.22	11.15	1.71	0.95	10.86

Table 7.2 continued

1	2	3	4	5	6	7	8	9	10
		Sugarcane			Potato			Dry chilli	
Trend value (b)	140.5	-23.37	14.41	38.26	10.44	3.86	-36.25	0.055	45.54
S.E. of b	39.155	11.85	4.081	15.89	4.14	1.17	11.44	0.0206	18.62
t value of b	3.588	1.97	3.53	2.41	2.52	3.29	3.17	2.664	2.44
Intercept (a)	3481. 3	931.4	66.68	441.2	88.03	69.89	2723.2	2.54	362.5
S.E. of a	129.86	39.3	13.54	52.7	13.74	3.09	37.94	0.068	61.76
r^2	0.588	0.301	0.58	0.39	0.41	0.54	0.527	0.441	0.399
F.value	12.87	3.89	12.47	5.8	6.34	10.0	10.06	7.8	5.98

	Cocoon production		Dairy Animal(T)		Price(Rs)	
	Production(tons)	Price/kg	Cow milk	Buffalo milk	Cow milk	Buff.milk
Trend value (b)	1313	1.554	-2967.9	576.8	0.1396	0.1974
S.E. of b	100.3	0.208	626.17	41.27	0.0156	0.0218
t value of b	13.09	7.439	4.74	13.97	8.88	7.37
Intercept (a)	2322	5.9053	137378	330.13	0.791	0.813
S.E. of a	305	0.6353	1904	125.5	0.0476	0.081
r^2	0.955	0.8737	0.74	0.96	0.8079	0.87
F.value	171.93	55.35	22.5	105.3	78.9	54.3

Table 7.3: Estimated number of breedable animals and milk production in rural area of Bangalore district.

Year	Number of crossbred cow	Milk production/day	Number of Hallikar cow	Milk production/day	Number of buffalo	Milk production/day
		kg		kg		kg
1970	36671	157444 ± 272.69	119177	178603 ± 805.9	54160	90081 ± 41.5
1981	38726	166685 ± 291.7	119433	179621 ± 803.25	56455	93680 ± 42.83
1972	41033	150080 ± 343.46	120606	181975 ± 904.35	58300	96608 ± 44.13
1973	39901	172205 ± 302.00	119151	179976 ± 802.96	59050	97660 ± 44.14
1974	38483	165624 ± 288.08	116973	176890 ± 789.26	59782	98684 ± 44.18
1975	36789	169992 ± 271.82	115063	174122 ± 805.11	60626	99852 ± 44.22
1976	34789	148309 ± 253.5	113278	171560 ± 765.0	61600	101210 ± 44.32
1977	32224	136162 ± 278.5	111760	169182 ± 770.35	62585	102613 ± 44.47
1978	29489	123221 ± 213.12	110189	166771 ± 878.02	63600	104038 ± 44.64
1979	26229	107718 ± 196.85	10880	164594 ± 985.62	64704	105583 ± 44.80

decrease in total number of cows as compared to buffaloes Consequently reduction in total cow's milk was seen to the extent of 2968 thousand kgs per year (that is 8131 kgs per day). This decrease was not counteracted by the increase in buffalo milk production which had risen 576 thousand per year in the district (Table 7.2).

Coefficient of variation in prices of cow and buffalo milk and in net return per each type of milch animal are brought out in Table 7.4. From the table it is observed that on average cow's milk was priced at Rs. 1.56 and that of buffalo at Rs. 1.90 per kg. The coefficient of variation for cow's milk price was 28.31 and buffalo milk was 33.69 per cent. Crossbreeding programme, started 1½ decades ago could increase the productivity per animal to the extent of 1543 kgs on average over 11 years, whereas local cows productivity remained 500 kgs and that of local buffalo 600 kg per year. The estimated cost of maintaining a milch animal on average, worked out to be Rs. 1462 for crossbred milch cow, Rs. 410 for local milch cow and Rs. 510 for buffalo. The gross return from cow's milk production in general, was Rs. 1373/year with variation of 31.31 per cent and buffalo milk production brought a gross return of Rs. 1140 per year with 33.21 per cent variation. The net return from crossbred cow was higher than other breed Hallikar or buffalo, but with higher variation too.

The perceived fluctuation in the net return per cow by the estimates had significant correlation

Table 7.4: Variability in Dairy Enterprise in Bangalore District - (Yield, Cost of Maintenance, Price of milk and net return) (1978-1979)

Particulars	Cow		Buffalo	
	Mean	CV	Mean	CV
Productivity/milk animal, kg.				
Local	500	-	-	-
Crossbred	1543	-	-	-
Price per kg of milk, Rs.	1.56	28.31	1.90	33.69
Cost of maintaining milch animal, Rs.				
Local	410	-	510	-
Crossbred	1462	-	-	-
Gross return per animal	1373	31.31	1140	33.21
Net return per animal:				
Local cow	447	12.5	630	19.03
Crossbred cow	945	21.6	-	-

with price of milk (0.9985) and net return per buffalo also had significant correlation with its milk price. The deviation from mean values of cost, price, net return and production are graphically represented in figure 15 and 16 (Appendix IX)U).

7.4 COCOON PRODUCTION

A decade of development brought a total quantity of cocoons 9547.42 tons which was increasing at a rate of 1313.54 tons per year in the district. Price per kg of cocoon was increasing at the rate of Rs. 1.55 per year. Production of cocoons was fluctuating 42.62 per cent whereas price was varying 27.29 per cent and that of gross margin only to the extent of 20 per cent. Graphically the deviation in the price cost net return and total production brought out in Figures 17 and 18 (Appendix IX)U.

7.5 INTER CROP AND INTER ENTERPRISE RELATION

If diversity of farm is considered as one of the remedy for stabilizing farm income, such of the crop combination or enterprise combination is preferred by which the total variability of the farm income could be reduced. Co-variance relationship (particularly when negative) are fundamental for effective diversification among farm enterprise as a means of hedging against uncertainty. Table 7.5 presents the correlation coefficient between various farm activities. From the table 7.5 it is observed that net return from paddy cultivation had significant positive correlation with

Table 4.5: Correlation coefficient between net returns of different farm activities.

Name of farm activities	Paddy	Ragi	Maize	Jowar	Horse-gram	Potato	Ground-nut	Sugar-cane	Hallikar cow	Cross-bred cow	Buffalo	Cocoon
Paddy	1											
Ragi	0.5225	1										
Maize	0.3567	0.1786	1									
Jowar	0.6358	-0.2731	0.6524	1								
Horsegram	0.1920	-0.5777	0.4061	0.1624	1							
Potato	0.6223	0.1326	0.1236	0.6122	-0.2600	1						
Groundnut	0.5336	0.0034	0.2851	0.3009	-0.098	0.5313	1					
Sugarcane	-0.2610	0.4694	0.0290	-0.0519	0.5598	-0.3566	-0.2189	1				
Hallikar cow	0.0849	0.6327	-0.1532	-0.2880	-0.3210	-0.4475	-0.3735	-0.694	1			
Crossbred-cow	0.0083	0.5828	-0.3526	-0.2870	-0.0887	0.0257	-0.3157	-0.5261	0.8998	1		
Buffalo	0.1304	0.3773	-0.0706	-0.0527	0.0722	-0.0337	0.1504	-0.5912	0.9051	0.7792	1	
Cocoon	0.4770	0.1915	-0.308	0.0199	-0.114	0.1180	0.4172	0.2582	0.2140	-0.1758	0.0579	1

net return from ragi, jowar, potato, groundnut and negative relation with sugarcane, distant and insignificant relation with maize, horsegram and dairy animals and cocoon production.

Taking net return from ragi crop, the competitive crops seemed to be jowar and horsegram which had negative relation, while significant positive relation was observed between net return from dairy animals and ragi crop. Other crops like maize, potato, groundnut, sugarcane and cocoon production had not had any significant relation when net return from both sides were correlated. Maize and dairy animals and maize and cocoons were having negative relation when net returns per unit were correlated. Jowar and maize were positively and significantly related and other crops, though were positively related were found not statistically significant. Net return from jowar and potato were positively related ($r = 0.6122$) other crops and other enterprises had no significant correlation. Horsegram and sugarcane were related positively. The correlation coefficient was 0.5598. When net return of other crop was related to that of net return from groundnut, significant correlation was found only with paddy. Potato had positive relation with jowar, paddy and groundnut in terms of net return per hectare. Sugarcane and dairy animals were negatively related enterprises.

148.74 per cent cropping intensity. The net income plan 4,5 and 6 could generate was Rs. 3662, 3839 and 5007 respectively.

Judged by the criteria for efficiency, plan 1 and 6 offered the optimum returns to resources on small farms. The bovines under plan 1 constituted of one dry crossbred cow and a heifer, one local cow and two buffaloes. After meeting family requirement, sale would be, cow milk 139 kg, buffalo milk 1064 kg, ragi 7.94 qtl and paddy 10.5 qtl. Other activities included maize for family needs, beetroot on 0.155 ha and grapes on 0.491 ha. The gross margin under plan 6 could be generated by 1004 kg cow milk, 20.43 qtl ragi, 9 qtl paddy, 15.01 qtl maize and mulberry on 0.0322 ha to feed 129 eggs of silk worms.

Among the risk efficient plans under Model II, plan 7 was adjudged to be the most appropriate for small farms. The plan could generate a net profit of Rs. 5480 (C.V. 5.99 per cent). The optimum level of activities were, ragi on 1.05 ha, paddy on 0.301 ha, maize on 0.147 ha, beetroot on 0.295 ha, grapes on 0.463 ha, sugarcane on 0.0274 ha, fodder on 0.00178 ha and one each of crossbred cow and buffalo yieldings 430 kg and 47.5 kg respectively for sale. Among the other plans not considered suitable were plan 8 with gross margin of Rs. 2310 (C.V. 14.21 per cent), plan 9 with Rs. 4178 (C.V. 17.23 per cent) and plans 10 and 11 which could earn only nominal profits of Rs. 705 and 757 with variability as high as 33.03 per cent and 32.99 per cent respectively.

Medium farmers, who are a shade better off than the small category in resource ownership could attain a net profit of Rs. 23557 by utilising their resources as stipulated in plans 1 and 2. Plans 3 through 6, which envisaged improved technological inputs could generate net profits of Rs. 16705, 18253, 19672 and 21133 in that order. Among which plan 6 was preferred. The activities in plan 6 consisted of 16.1 qtl, ragi for sale after home consumption from 2.124 ha, paddy on 0.189 ha in each season for household, 56.4 qtl of marketable maize from 1.027 ha, carrot on 0.445 ha, mulberry on 0.240 ha to feed 0.664 units of cocoon, 1 crossbred cow (3500 kg/year) and 0.294 ha of soobabul. Tested for its risk efficient operation under Model II, plan 11 (plan 6 in Model I) could generate Rs. 12407 (C.V. 4.57 per cent) with some reallocation of the resources. The area under ragi, paddy and maize would be 0.767 ha, 0.567 ha and 0.66 ha. The surplus maize for sale would be reduced to 34.8 qtl. So would be the case with mulberry on 0.393 ha. for 0.0167 units of cocoon. Dairy activity would be of the order of 1.52 units crossbred cow (3000 kg/year) sustained by 0.445 ha soobabul and 0.00373 ha. of jowar, but only part of the surplus milk (275 kg) would enter sellings activity, the rest moving to disposal activity for want of higher prices.

The net profit that could be earned by implementing the alternative plans under Model II were, Rs. 17202

(C.V. 1.86 per cent) by plan 7, Rs. 3873 (C.V. 8.27 percent) by plan 8, Rs. 8429 (C.V. 20.72 percent) by plan 9 and Rs. 10049 (C.V. 8.73 percent) by plan 10. Technological aspects, low profits and high variation made these plan alternatives unsuitable for recommendation to medium farmers.

The large farmers, despite their strongest resource base among all farm situations, were operating under sub optimal conditions. The resource reallocation under plans 1 and 2 would generate a gross margin of Rs. 52583 with borrowed capital of Rs. 37160 and cropping intensity of 155.43 per cent. With the accent on improved technological inputs, plans 3,4 and 5 could yield net profit to the tune of Rs. 38851, 43927 and 29163 respectively, while plan 6 with 172.03 per cent cropping intensity could generate Rs. 34093. On the basis of the land and capital constraints, plan 4 was recommended to be the best alternative for large farm group. The activities entering this plan were, one crossbred cow, 0.589 ha, unirrigated land for soobabul, 0.281 ha, unirrigated land for jowar, 0.313 irrigated land for green fodder, 4.73 ha unirrigated land 1.6 ha irrigated land for ragi, 0.375 ha irrigated land in each season for paddy and 2.70 ha for maize.

With the incorporation of risk element in the plans under Model II, the whole scenario underwent drastic change and the susceptibility of the plans to variation in terms of income was brought to the fore. Plans 7 through 11 could yield gross margin of the order of Rs. 43569

(C.V. 1.54), Rs. 26491 (C.V. 1.97 percent), Rs. 20190 (C.V. 21.43 percent), Rs. 31300 (C.V. 4.93 percent) and Rs. 47692 (C.V. 2.70 percent) respectively. Judged by the axiom of maximum returns with minimum variation plan 10 and 11 were found to be most beneficial and were recommended for large farms.

An overall view of the four farm situations and their adaptability to the optimum plans without conside-ring risk element and with the more logical approach of incorporating risk revealed that the marginal and small farms are the most vulnerable to risk. The sharp differences in the level of activities and gross margins generated through optimum plans under Model I and II bear testimony to this fact. The differences in the recommended optimum plans under Model I and II were 58.55 per cent, 62.5 per cent, 41.3 per cent and 28.75 per cent respectively for marginal, small, medium and large farms.

Shadow prices, which are crucial indicators for farm plans, showed the need for more remunerative prices to put the farm enterprise on an advanced technological footing. The shadow prices of land ranged between Rs. 5000 and 8000, amply demonstrates the vast scope of benefits that can be availed by all categories of farmers by improving land productivity by irrigation and land development measures. Because of the necessity to demarcate land for fodder and the cost of purchased inputs, crossbred cow milk had a higher shadow price than buffalo milk except in plan 6. It varied between Rs. 2.11 to Rs. 3.01 per kg whereas for buffalo milk the range was Rs. 1.77 and 2.11 per kg. The highest shadow price for ragi was observed in rabi at Rs. 199/qtl obviously due to irrigation and during the other two seasons the minimum was Rs. 99/qtl. In the case of paddy, the shadow prices were higher during kharif and rabi seasons, ranging between Rs. 252 and 318/qtl and the minimum of Rs. 182/qtl in summer. While maize had no higher shadow price than the existing level, soobabul and jowar exhibited exorbitantly high prices of Rs. 139.66 and 221/qtl. Labour was found to be surplus in all farm situations hence indicating the scope of utilising it in household industries.

The results of the study conclusively proved that the adaptability of improved technology vary with the type of the farm in the study area. There was no evidence to suggest that dairying with crossbred cows as advanced technology is size-neutral. The inefficiency of the marginal and small farms to withstand risk as revealed by risk efficient optimum plans shows that land is the unique and biggest constraint in enhancing the income of these two farm situations even with improved technological inputs. The conclusion is further strengthened by the inability of these farms to absorb credit even after assuming its unlimited availability. To have risk efficient production frontier under improved technology, land, rather than capital is the prime input. The exercise on opportunity cost revealed that there is immense scope for increasing its productivity. Thus, assuming the difficult policy implications of increasing land availability to the marginal and small groups, the practical measure would be to increase the productivity of the available land by providing irrigation and other land development facilities. To make milk production by crossbred cows profitable, provision of subsidised or cheap feed inputs that meet minimum nutritional requirements would go a long way. Thus, development of fodder farms and rationing of fodder to the small land owners undertaking dairying could help enhance milk production to benefit both producers and consumers. The medium and large farms, on the other hand, could remarkably increase their profit prospects by adopting the stipulated risk efficient optimum plans. The study having conducted in the context of dry land farming with diverse enterprises like food-crops, cash crops, dairying and silk-worm rearing, the results could be applicable to similar areas with similar cultural practices.

The study suffers from some limitations, mainly, due to the resource constraints experienced by the investigator. Firstly, in formulating the risk neutral and risk efficient optimum plans, the activities included were uniformly applied to all farm situations irrespective of the innate and unquantifiable but obvious differences among them. The activities for different farm situations could have been devised in tune with their resource position and socio-economic standing. Secondly, marketing of crossbred and other cattle, widely practised in the study area was excluded from the plans with improved technology because of the emphasis on milk production. Inclusion of cattle marketing could have totally changed the scenario of dairy enterprise from what was observed in the results. Thirdly, the price of milk considered in the study was that at the existing level, assumption of more incentive price could have taken milk production to a higher plane as revealed by shadow prices. In other words, variable price programming could show milk production at different price levels. The fourth limitation of the study is the assumption of risk aversion by farmers. Thus risk efficient optima were worked out for minimum variation while incorporation of maximum variation could have exhibited situation of the risk takers in a better way. Finally, activities like piggery, sheep, goat and poultry which supplement the income of farmers as well as improve the economic viability of the farm business were not incorporated as paucity of reliable data posed a formidable problem.

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A P P E N D I C E S

APPENDIX I

Performance of Bovine Population in Sample area of Bangalore district - Rural area alone

Name of the Taluk	Crossbred cow			Local cow			Buffalo		
	Per day milk yield kg	Milking days	Total yield kg	Per day milk yield kg	Milking days	Total yield kg	Per day milk yield kg	Milking days	Total yield kg
Bangalore South	4.53 (53)	286	1304	2.75 (31)	248	682	3.54 (13)	227	804
Bangalore North	5.47 (52)	320	1750	3.41 (12)	303	1033	3.05 (9)	155	473
Anekal	5.99 (41)	295	1767	2.83 (16)	249	705	2.3 (11)	241	554
Hosakote	7.13 (53)	275	1961	2.86 (12)	243	695	2.27 (37)	232	527
Channapatna	4.31 (10)	253	1090	2.62 (49)	199	521	2.39 (20)	240	574
Ramnagaram	7.22 (23)	273	1971	2.12 (10)	209	443	2.82 (22)	260	733
Devanahalli	6.94 (73)	267	1853	0.85 (5)	218	403	1.97 (31)	231	455
Doddaballapur	6.1 (61)	257	1568	2.84 (34)	223	633	2.76 (62)	256	707

Figures in parenthesis indicate the number of observations.

APPENDIX - II

Name of Taluk	Code No. in the map	Names of selected villages
	1	Attibele
	2	Ramsagara
Anekal	3	Halegee
	4	Hebbagodi
	5	Indalabele
	6	Nandagudi
Hosakote	7	R.G. Pura
	8	Kannur
	9	H.S. Halli
	10	Hirendehalli
	11	Chokkasandra
	12	Vijayapura
	13	Yelavahalli
	14	Chikkanahalli
Devanahalli	15	Pura
	16	Doddasana
	17	Bagalur
	18	H.N. Halli
	19	V.N. Pura
	20	Bydrahalli
	21	Melekote
	22	Marahalli
	23	Kantana Kunte
Doddaballapura	24	Veddarahalli
	25	Kodagahalli
	26	Nagasandra
	27	Madhura
	28	K.K. Palya
	29	Hanabe
	30	Gundasandra
	31	Shirivara

Name of Taluk	Code No. in the map	Names of selected villages
Bangalore North	32	Hesserghatta
	33	Guddahalli
	34	Seerasandra
	35	Bytha
	36	Avalahalli
Bangalore South	37	Gunjur
	38	Munekola
	39	Todbarahalli
	40	B.N. Pura
	41	Immadahalli
	42	Nagasandra
Ramnagara	43	Laxmi Pura
	44	Koote gal
	45	Anna halli
	46	Gungara halli
Channapatna	47	Kodipura
	48	Munkunda
	49	Deveralalli
	50	Kommanalalli
	51	Rampura

APPENDIX - III

Distribution of different breeds/Species of Adult Dairy Animals

(Percentages)

Type of Breed/ Species of animals	Category of Farms			
	Marginal farm	Small farm	Medium farm	Large farm
A) Crossbred cows				
i. Holstein Freisian crosses	25.90	20.65	22.30	24.00
ii. Red Dane crosses	4.00	4.72	5.70	7.70
iii. Jersey crosses	12.70	9.70	6.40	7.70
iv. Miscellaneous crosses	8.30	4.48	7.50	11.50
B) Local cows (Hallikar breed)	25.90	38.80	29.50	20.20
C) Buffaloes	23.20	21.89	28.60	28.90
Proportion of crossbred to total	50.90	39.31	41.90	50.09

APPENDIX - IV

Proportions of different ingredients of concentrate mixture and its price

Marginal Farm

Months	GNC	WB	Husk	Feed	Rice bran	Cotton seed	Others	Price, kg
July	20.79	21.19	4.35	7.84	45.69	-	0.45	0.85
August	12.33	28.95	6.23	6.69	45.8	-	-	0.85
September	17.87	21.15	2.46	9.87	48.65	-	-	0.78
October	14.75	22.80	5.13	13.81	43.51	-	-	0.87
November	12.52	31.12	4.40	9.69	42.27	-	-	0.79
December	10.79	31.52	5.56	8.94	43.2	-	-	0.90
January	13.28	24.27	5.73	10.09	44.71	-	-	0.88
February	14.07	21.46	2.98	6.13	54.66	0.70	1.92	0.84
March	13.58	23.92	5.23	4.52	51.20	1.58	-	0.86
April	12.77	22.77	1.56	5.69	53.86	1.43	1.92	0.86
May	11.60	25.45	3.67	5.96	52.36	0.96	-	0.88
June	11.30	14.97	2.92	6.67	63.18	0.96	-	0.89
Mean	13.80	24.13	4.19	7.97	49.08	0.47	0.36	0.84
C.V.	21.08	19.40	34.65	32.63	12.8	-	-	5.85

APPENDIX - IVa

Proportion of different ingredients of concentrate mixture
and its prices

Small farm

Months	GNC	WB	Husk	Feed	Rice bran	Cotton seed	Others	Price/ kg, Rs.
July	17.16	20.33	4.05	7.22	51.24	-	0.27	0.7
August	17.55	21.56	1.52	8.01	51.09			0.64
September	14.98	27.20	1.61	8.2	51.01			0.64
October	14.46	26.10	1.65	6.09	51.00		0.45	0.62
November	11.61	29.85	3.09	6.11	48.89		0.35	0.66
December	14.99	27.36	4.14	6.02	47.14		0.26	0.68
January	16.73	25.10	3.04	7.68	47.19			0.69
February	19.31	22.54	3.32	4.92	49.91			0.72
March	21.05	21.44	2.85	4.8	49.86			0.78
April	17.35	29.24	4.11	4.14	45.16			0.69
May	17.55	26.33	2.39	4.34	50.39			0.70
June	16.11	19.97	1.61	4.4	57.91			0.64
Mean	16.57	24.75	2.78	5.66	50.12		0.12	0.68
C.V	14.68	14.04	36.87	29.72	6.53			6.49

APPENDIX - IVb

Proportion of different ingredients of concentrate mixture
and its price

Medium Farm

Months	GNC	WB	Husk	Feed	Rice bran	Others	Total	Price/kg
July	20.99	32.12	2.37	11.24	29.00	4.28	100	0.86
August	17.35	27.78	2.19	9.64	41.16	1.88		0.80
September	16.63	30.44	2.08	9.4	40.00	1.45		0.79
October	15.36	33.43	3.05	7.83	40.33			0.77
November	14.75	35.29	4.02	10.93	33.5	1.45		0.80
December	14.74	38.67	6.5	8.8	31.29			0.80
January	15.27	35.13	4.95	7.75	35.6	1.3		0.88
February	20.92	33.01	4.24	6.64	33.39	1.8		0.86
March	19.77	28.35	9.17	6.18	34.83	1.7		0.88
April	19.93	28.47	4.79	9.16	34.75	2.9		0.84
May	18.47	27.43	6.22	7.89	36.89	3.1		0.91
June	16.45	25.20	5.4	7.07	42.68	3.2		0.96
Mean	17.55	31.28	4.58	8.55	36.12	1.92		0.84
C.V.	32.9	12.66	45.65	30.2	11.58			11.91

APPENDIX-IVc

Proportion of different ingredients of concentrate mixture and its price

Large Farm

Months	GNC	WB	Husk	Feed	Rice bran	Others	Total	Price/kg
July	17.97	26	1.3	23.45	28.68	2.6	100	0.91
August	25.9	24.34	0.28	12.34	34.02	3.12	,,	0.89
September	24.17	30.06	1.02	20.88	20.75	3.12	,,	0.94
October	13.15	29.01	0.82	15.45	38.45	3.12	,,	0.84
November	15.62	30.91	3.39	20.32	27.12	2.64	,,	0.91
December	16.67	32.25	4.11	23.19	20.65	3.13	,,	0.96
January	15.06	35.05	6.29	18.69	21.79	3.12	,,	0.93
February	17.02	33.9	3.86	11.78	30.59	2.85	,,	0.99
March	20.33	27.4	4.57	15.53	29.32	2.85	,,	1.00
April	21.63	28.46	3.92	13.98	28.64	3.37	,,	0.96
May	18.91	30.35	2.55	6.83	37.49	3.87	,,	0.90
June	19.24	35.3	1.49	8.74	33.63	1.6	,,	0.92
Mean	18.8	30.25	2.8	15.93	29.26	2.95		0.93
C.V.	20.1	11.59	65.1	34.39	20.71			1.89

APPENDIX - V

Opportunity cost of feeds and fodders which are in non-plan

Name of fodder/ feed not used in the plan	Price/kg. in Rs.		
	At the time of study	At which feed will be included in the plan	
		I	II
Napier	0.09	0.05	0.04
Miscellaneous grass	0.06	0.02	0.02
Ragi straw	0.23	0.09	0.12
Paddy straw	0.17	0.08	0.12
Rice bran	0.40	0.30	0.15
Wheat bran	1.44	0.57	0.16
Gram husk	1.15	0.09	0.12
GNC	1.50	-	0.04
Feed	1.19	1.14	1.01

APPENDIX - VI

Shadow prices of Nutrients and feed constraints

Name of Nutrient/Feed	Shadow price	
	Plan I	Plan II
Dry matter	0.09	0.13
Digestible Crude Protein	3.63	-
Metabolizable Energy	-	-
Calcium	-	-
Phosphorous	-	3.1
Mulberry	0.05	-

APPENDIX - VII

Proportion of farmers taken preventive and curative measures for milch animals

Type of farm	Percentage of farmers taken precaution against diseases like					Not taken any preventive measure	Percentage farmers taken curative measures
	Rinder pest	Anthrax	Black quarter	Brucellosis	Foot and mouth		
Marginal	11.76	-	23.53	2.94	29.41	32.35	37.04
Small	15.38	-	19.23	-	32.77	34.62	57.60
Medium	8.77	1.75	15.79	5.26	14.26	54.38	32.85
Large	7.41	3.7	37.04	3.70	33.33	14.81	56.25
Overall	11.59	1.00	21.55	2.68	26.70	37.24	45.66

APPENDIX - VII(a)

Activities code

P1.1 Crossbred cow Type 1
P1.2 Crossbred cow Type 2
P1.3 Crossbred Dry cow
P1.4 Crossbred heifer

P2.1 Haliker cow Type I
P2.2 Hallikar cow Type II
P2.3 Hallikar cow dry
P2.4 Hallikar heifer

P3.1 Buffalo Type I
P3.2 Buffalo Type II
P3.3 Buffalo dry
P3.4 Buffalo heifer

P4.1 Cow milk sale (during kharif season)
P4.2 Cow milk sale (during rabi season)
P4.3 Cow milk sale (during summer season)

P5.1 Buffalo milk sale (during kharif season)
P5.2 Buffalo milk sale (during rabi season)
P5.3 Buffalo milk sale (during summer season)

P6.1 Ragi local variety - unirrigated land - kharif season
P6.2 Ragi improved variety - unirrigated land-kharif season
P6.3 Ragi improved variety - Irrigated land - kharif season
P6.4 Ragi, local variety with jowar & avarai - Unirrigated land - kharif season
P6.5 Ragi, improved variety with jowar & avarai - Unirrigated kharif season
P6.6 Ragi improved variety-irrigated land-rabi season
P6.7 Ragi improved variety-irrigated land-summer season.

P7.1 Paddy local variety - kharif season
P7.2 Paddy improved variety - kharif season
P7.3 Paddy improved - rabi season
P7.4 Paddy improved - summer season

P8.1 Groundnut - kharif unirrigated
P8.2 Groundnut- summer irrigated

P9.1 Maize - kharif
P9.2 Maize - rabi

P10.1 Horsegram - unirrigated - kharif
P11.2 Jowar - unirrigated - kharif

P12.1 Tomato - kharif season
P12.2 Tomoto - rabi season

P13.1 Carrot - kharif
P13.2 Carrot - summer

P14 Brinjal - kharif
P15 Beetroot - kharif
P15.1 Beans - kharif

P16 Chilli - rabi
P17 Potato - rabi
P18 Grapes
P19 Sugarcane
P20.1 Green fodder - irrigated
P20.2 Soobabul - unirrigated
P21 Mulberry - irrigated
P22 Cucumber - summer
P23.1 Hired labour - period I
P23.2 Hired labour - Period II
P23.3 Hired labour - period III
P23.4 Hired labour - period IV
P23.5 Hired labour - period V
P23.6 Hired labour - period VI

P24.1 Hired bullock labour - period I
P24.2 Hired bullock labour - period III
P24.3 Hired bullock labour - period V

P25.1 Capital borrowing - kharif
P25.2 Capital borrowing - rabi
P25.3 Capital borrowing - summer

P26 Purchase of ragi strew

P27.1 Sale of ragi - kharif season

P27.2 Sale of ragi - rabi season

P27.3 Sale of ragi - summer season

P28.1 Sale of paddy - kharif season

P28.2 Sale of paddy - rabi season

P28.3 Sale of paddy - summer season

P29.1 Sale of maize - kharif season

P29.2 Sale of maize - rabi season

P30.1 Purchase of ragi - kharif season

P30.2 Purchase of ragi - rabi season

P30.3 Purchase of ragi - summer season

P31.1 Purchase of paddy - kharif season

P31.2 Purchase of paddy - rabi season

P31.3 Purchase of paddy - summer season

P32.1 Purchaseof milk - kharif season

P32.2 Purchase of milk - rabi season

P32.3 Purchase of milk - summer season

P33.1 Transfer activity - kharif to rabi

P33.2 Transfer activity - rabi to summer

P33.3 Transfer activity - summer to farm income

P34.1 Cocoon variety - small

P34.2 Cocoon variety - medium

P34.3 Cocoon variety - large

P35.1 to 35.11 Negative Deviation from trend value.

APPENDIX - VII(b)

Constraints code

R 1.1	Land irrigated - kharif (hectare)
R 1.2	Land unirrigated - kharif (hectare)
R 1.3	Land irrigated - rabi (hectare)
R 1.4	Land irrigated - summer (hectare)
R 2.1	Family labour period 1 (man days)
R 2.2	Family labour period 2 (man days)
R 2.3	Family labour period 3 (man days)
R 2.4	Family labour period 4 (man days)
R 2.5	Family labour period 5 (man days)
R 2.6	Family labour period 6 (man days)
R 3.1	Bullock labour period 1 (pair days)
R 3.2	Bullock labour period 2 (pair days)
R 3.3	Bullock labour period 3 (pair days)
R 3.4	Bullock labour period4(pair days)
R 3.5	Bullock labour period 5 (pair days)
R 3.6	Bullock labour period 6 (pair days)
R 4.1	Capital - kharif (rupees)
R 4.2	Capital - rabi (rupees)
R 4.3	Capital - summer (rupees)
R 5	Space for livestock (square metre)
R 6.1	Green fodder minimum requirement
R 6.2	Ragi straw minimum requirement
R 6.3	Paddy straw minimum requirement
R 6.4	Maize khadibi minimum requirement
R 7.1	Cow milk - kharif minimum requirement
R 7.2	Cow milk - rabi minimum requirement
R 7.3	Cow milk - summer minimum requirement
R 8.1	Buffalo milk - kharif minimum requirement
R 8.2	Buffalo milk - rabi minimum requirement
R 8.3	Buffalo milk - summer minimum requirement
R 9.1	Ragi - kharif minimum requirement
R 9.2	Ragi - rabi minimum requirement
R 9.3	Ragi - summer minimum requirement

R 10.1	Paddy - kharif minimum requirement
R 10.2	Paddy - rabi minimum requirement
R 10.3	Paddy - summer minimum requirement
R 11.1	Maize - kharif minimum requirement
R 11.2	Maize - rabi minimum requirement
R 12	Number of cows
R 13	Number of buffaloes

Appendix VIII

Constraints and problem matrix for Marginal synthetic farm at existing level of Technology, Bangalore District, 1979-80

R_i /Pj		P1.1	P1.2	P1.3	P1.4	P2.1	P2.2	P2.3	P2.4	P3.1	P3.2	P3.3	P3.4	P4.1	P4.2	P4.3	P5.1	P5.2	P5.3
R1.1	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R1.2	0.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R1.3	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R1.4	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R2.1	79.4	8.19	2.27	0.71	1.99	8.12	4.04	2.79	4.46	7.29	2.16	2.16	5.09	0	0	0	0	0	0
R2.2	229	29.47	17.57	7.79	29.42	25.95	12.80	16.99	16.31	28.41	10.10	14.07	14.06	0	0	0	0	0	0
R2.3	79.34	11.62	5.10	2.81	7.13	11.17	4.99	2.77	4.18	11.21	4.31	5.36	4.33	0	0	0	0	0	0
R2.4	229	28.09	19.40	8.24	14.64	24.72	17.77	8.57	10.16	24.60	12.31	12.45	9.45	0	0	0	0	0	0
R2.5	79.04	5.45	6.72	1.05	1.62	7.99	2.89	8.81	5.86	8.68	1.04	4.96	3.30	0	0	0	0	0	0
R2.6	229	23.04	12.89	1.47	5.65	26.43	8.76	7.56	16.76	23.16	9.73	17.98	13.33	0	0	0	0	0	0
R3.1	3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.2	5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.3	4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.4	13.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.5	4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.6	13.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R4.1	3970	532	470	185	305	187	115	76	103	180	51	84	78	-1.43	0	0	-1.5	0	0
R4.2	0	486	406	231	210	229	102	41	65	155	40	89	44	0	-1.56	0	0	-1.9	0
R4.3	0	433	280	77	65	132	26	28	109	168	87	113	58	0	0	-1.6	0	0	-2.0
R5.0	15.6	7.13	7.13	7.13	3.82	5.09	5.09	5.09	3.82	6.36	6.36	6.36	3.82	0	0	0	0	0	0
R6.1	0	-1.57	-0.74	-0.37	-0.51	-0.99	-0.35	-0.35	-0.47	-0.88	-0.40	-0.47	-0.36	0	0	0	0	0	0
R6.2	0	-10.02	-2.50	-1.05	-3.26	-3.25	-1.56	-1.56	-2.50	-3.82	-2.68	-0.45	-2.68	0	0	0	0	0	0
R6.3	0	-5.50	-1.37	-0.58	-1.78	-1.78	-0.85	-0.90	-1.73	-2.08	-1.47	-0.25	-1.47	0	0	0	0	0	0
R6.4	0	-2.26	-0.54	-0.23	-0.74	-0.73	-0.35	-0.37	-0.54	-0.83	-0.58	-0.09	-0.58	0	0	0	0	0	0
R7.1	107	441	333	0	0	147	149	0	0	0	0	0	0	-1	0	0	0	0	0
R7.2	107	400	282	0	0	220	133	0	0	0	0	0	0	0	-1	0	0	0	0
R7.3	107	367	203	0	0	99	36	0	0	0	0	0	0	0	0	-1	0	0	0
R8.1	0	0	0	0	0	0	0	0	0	170	111	0	0	0	0	0	-1	0	0
R8.2	0	0	0	0	0	0	0	0	0	147	88	0	0	0	0	0	0	-1	0
R8.3	0	0	0	0	0	0	0	0	0	160	193	0	0	0	0	0	0	0	-1
R9.1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R11.1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R12.0	0	1	1	0	-1	1	1	0	-1	0	0	0	0	0	0	0	0	0	0
R13.0	0	0	0	0	0	0	0	0	0	1	1	0	-1	0	0	0	0	0	0

R3 / P2	P6.1	P6.2	P6.4	P6.7	P7.2	P1.3	P2.4	P8.1	P11.2	P12.2	P13.2	P20.1	P27.1	P28.1	P28.2	P28.3	P29.1	P26.0
R1.1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0
R1.2	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
R1.3	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0
R1.4	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
R2.1	25.59	21.78	25.44	0	38.83	0	0	58.28	0	0	0	14.82	0	0	0	0	0	0
R2.2	39.29	35.98	31.34	0	74.11	0	0	71.88	0	0	0	14.82	0	0	0	0	0	0
R2.3	0	0	0	0	0	56.23	0	0	56.81	15.61	76.57	4.94	0	0	0	0	0	0
R2.4	0	0	0	0	0	53.11	0	0	48.40	38.28	202.05	14.82	0	0	0	0	0	0
R2.5	0	0	0	28.13	0	0	48.34	0	0	0	0	4.94	0	0	0	0	0	0
R2.6	0	0	0	36.28	0	0	58.54	0	0	0	0	14.82	0	0	0	0	0	0
R3.1	29.64	7.81	17.69	0	21.74	0	0	7.60	0	0	0	1.64	0	0	0	0	0	0
R3.2	7.85	7.85	14.03	0	2.72	0	0	0	0	0	0	4.92	0	0	0	0	0	0
R3.3	0	0	0	0	0	28.85	0	0	4.94	14.33	14.82	1.64	0	0	0	0	0	0
R3.4	0	0	0	0	0	2.72	0	0	0	0	0	4.92	0	0	0	0	0	0
R3.5	0	0	0	17.78	0	0	44.71	0	0	0	0	1.64	0	0	0	0	0	0
R3.6	0	0	0	14.03	0	0	2.72	0	0	0	0	4.92	0	0	0	0	0	0
R4.1	494	715	823	0	1562	0	0	1102	0	0	0	681	-95	-134	0	0	-129	0
R4.2	0	0	0	0	0	1304	0	0	2008	1133	2322	681	0	0	-106	0	0	40
R4.3	0	0	0	1564	0	0	1693	0	0	0	0	681	0	0	0	-112	0	40
R5.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R5.1	0	0	0	0	0	0	0	0	0	0	0	204	0	0	0	0	0	0
R5.2	15.11	16.5	18.15	24.68	0	0	0	0	0	0	0	0	0	0	0	0	0	1
R6.3	0	0	0	0	18.97	16.0	25.31	0	0	0	0	0	0	0	0	0	0	0
R6.4	0	0	0	0	0	0	0	13.9	0	0	0	0	0	0	0	0	0	0
R7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.3	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0
R8.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.1	10.84	12.57	12.57	16.3	0	0	0	0	0	0	0	0	-1	0	0	0	0	0
R10.1	0	0	0	0	37.91	0	0	0	0	0	0	0	0	-1	0	0	0	0
R10.2	0	0	0	0	0	35.35	0	0	0	0	0	0	0	0	-1	0	0	0
R10.3	0	0	0	0	0	0	30.95	0	0	0	0	0	0	0	0	-1	0	0
R11.1	0	0	0	0	0	0	0	19.76	0	0	0	0	0	0	0	0	-1	0
R12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R13.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Ri/Pj	P23.1	P23.2	P23.3	P23.4	P24.1	P24.2	P24.3	P25.1	P25.2	P25.3	P35.1	P36.1	P36.2	P36.3	P33.1	P33.2	P33.3	P34.1	P34.2	P34.3
R1.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
R1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]
R1.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
R1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
R2.1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48.1	48.1	59.2
R2.2	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	114.7	114.7	117.8
R2.3	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48.1	48.1	59.2
R2.4	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	114.7	114.7	117.8
R2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48.1	48.1	59.2
R2.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	114.7	114.7	117.8
R3.1	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	2.34	2.34	2.34
R3.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.13	7.13	7.13
R3.3	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	2.34	2.34	2.34
R3.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.13	7.13	7.13
R3.5	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	2.34	2.34	2.34
R3.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.13	7.13	7.13
R4.1	0	0	0	0	20	0	0	-100	0	0	99	134	0	0	1	0	0	992	1392	1563
R4.2	0	0	0	0	0	20	0	0	-100	0	0	0	102	0	-1	1	0	992	1392	1563
R4.3	0	0	0	0	0	0	20	0	0	-100	0	0	0	112	0	-1	1	992	1392	1563
R5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.1	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0
R10.1	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0
R10.2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
R10.3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
R11.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R13.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix VIII

Constraints and problem Matrix for Small Synthetic Farm at existing level of Technology, Bangalore District, 1979-80

Ri/Pj		P1.1	P1.2	P1.3	P1.4	P2.1	P2.2	P2.3	2.4	P3.1	P3.2	P3.3	P3.4	P4.1	P4.2	P4.3	P5.1	P5.2	P5.3
R1.1	0.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R1.2	1.51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R1.3	0.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R1.4	0.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R2.1	77.5	10.43	7.07	2.20	3.12	5.85	3.34	2.38	3.10	5.83	1.28	3.85	3.64	0	0	0	0	0	0
R2.2	233	32.92	27.48	18.54	3.73	25.58	16.43	17.03	11.32	20.75	11.63	11.53	7.20	0	0	0	0	0	0
R2.3	77.6	6.90	5.83	4.14	1.40	8.56	6.33	5.81	3.83	7.89	2.91	3.00	2.75	0	0	0	0	0	0
R2.4	233	21.77	20.92	11.70	6.16	21.60	9.65	13.68	8.39	17.30	11.11	7.89	13.40	0	0	0	0	0	0
R2.5	77.6	5.70	6.02	3.22	1.73	3.59	2.20	2.93	2.22	5.13	2.57	3.18	3.27	0	0	0	0	0	0
R2.6	233	15.58	18.49	3.83	6.52	17.24	11.90	8.12	7.71	15.46	3.05	15.64	12.42	0	0	0	0	0	0
R3.1	18.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.2	56.81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.3	18.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.4	56.81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.5	18.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.6	56.81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R4.1	3405	565	285	247	199	158	130	104	77	173	126	87	75	-1.43	0	0	-1.6	0	0
R4.2	0	551	237	132	210	148	112	103	71	183	171	72	100	0	-1.56	0	0	-1.9	0
R4.3	0	614	264	77	215	156	118	81	80	156	73	90	8	0	0	-1.5	0	0	-2.0
R5.0	23.48	5.73	5.73	5.73	2.86	4.09	4.09	4.09	2.86	5.12	5.12	5.12	2.56	0	0	0	0	0	0
R6.1	0	-7.69	-2.73	-1.46	-1.43	-4.70	-2.03	-3.24	-2.39	-4.89	-2.19	-2.67	-2.17	0	0	0	0	0	0
R6.2	0	-10.43	-9.78	-3.17	-3.56	[illegible]	-3.72	-5.96	[illegible]	-7.50	-4.56	-4.64	-4.27	0	0	0	0	0	0
R6.3	0	-2.42	-2.27	-0.73	-0.83	-1.96	-0.83	-1.38	-1.25	-1.74	-1.15	-9.08	-6.99	0	0	0	0	0	0
R6.4	0	-1.63	-1.53	-0.50	-0.56	-1.32	-0.50	-0.94	-0.84	-1.17	-0.78	-0.72	-0.68	0	0	0	0	0	0
R7.1	138	569	235	0	0	191	148	0	0	0	0	0	0	-1	0	0	0	0	0
R7.2	138	488	186	0	0	175	119	0	0	0	0	0	0	0	-1	0	0	0	0
R7.3	138	514	285	0	0	187	129	0	0	0	0	0	0	0	0	-1	0	0	0
R8.1	0	0	0	0	0	0	0	0	0	176	80	0	0	0	0	0	-1	0	0
R8.2	0	0	0	0	0	0	0	0	0	190	119	0	0	0	0	0	0	-1	0
R8.3	0	0	0	0	0	0	0	0	0	186	35	0	0	0	0	0	0	0	-1
R9.1	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R11.1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R11.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R12.0	0	1	1	0	-1	1	1	0	-1	0	0	0	0	0	0	0	0	0	0
R13.0	0	0	0	0	0	0	0	0	0	1	1	0	-1	0	0	0	0	0	0

Rj/Pj	P6.1	P6.2	P6.3	P6.8	P6.7	P7.2	P7.3	P7.4	P9.1	P9.2	P8.1	P8.2	P11.0	P12.0	P14.0	P15.0	P16.0	P18.0	P19.0	P20.0	P21.1
R1.1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	1	0	1	1	0
R1.2	1	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
R1.3	0	0	0	[illegible]	0	0	1	0	0	1	0	0	0	0	1	0	0	1	1	1	0
R1.4	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	1	0
R2.1	18.45	14.48	36.10	0	0	33.60	0	0	29.02	0	26.38	0	5.09	1.35	0	0	40.38	0	51.87	14.82	0
R2.2	20.77	30.10	30.[illegible]	0	0	75.19	0	0	21.86	0	50.54	0	17.78	20.77	0	0	128.44	0	24.70	14.82	0
R2.3	0	0	0	38.93	0	0	33.30	0	0	28.65	0	0	0	0	50.83	0	0	29.64	81.60	6.94	0
R2.4	0	0	0	29.88	0	0	81.75	0	0	121.80	0	0	0	0	63.65	0	0	109.17	12.35	14.32	0
R2.5	0	0	0	0	20.25	0	0	38.28	0	0	0	26.38	0	0	0	247	0	0	37.05	4.94	0
R2.6	0	0	0	0	57.53	0	0	97.89	0	0	0	82.74	0	0	0	152	0	0	39.45	14.82	0
R3.1	14.81	13.31	20.85	0	0	23.32	0	0	22.23	0	36.56	0	4.94	9.88	0	0	14.82	0	20.75	1.64	0
R3.2	13.09	19.[illegible]	19.36	0	0	16.45	0	0	0	0	11.86	0	6.18	0	0	0	0	0	14.82	4.92	0
R3.3	0	0	0	27.66	0	0	31.20	0	0	28.35	0	0	0	0	4.94	0	0	39.52	0	1.64	0
R3.4	0	0	0	13.35	0	0	14.72	0	0	0	0	34.58	0	0	0	4.94	0	0	0	4.92	0
R3.5	0	0	0	0	12.84	0	0	60.52	0	0	0	4.94	0	0	0	0	0	0	0	1.64	0
R3.6	0	0	0	0	13.46	0	0	14.82	0	0	0	0	0	0	0	0	0	0	0	4.92	0
R4.1	565	1272	895	0	0	1233	0	0	1319	0	355	0	133	311	0	0	1236	0	1309	239	-95
R4.2	0	0	0	1345	0	0	1513	0	0	4215	0	0	0	0	1224	0	0	4952	1000	235	0
R4.3	0	0	0	0	1361	0	0	2676	0	0	0	756	0	0	0	1529	0	0	1904	239	0
R5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	71.60	0
R6.2	15.70	16380	38.20	7.82	11.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.3	0	0	0	0	0	45216	38239	66200	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.4	0	0	0	0	0	0	0	0	46	34	0	0	0	0	0	0	0	0	0	0	0
R7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.1	9.12	11.20	21.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1
R9.2	0	0	0	5.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.3	0	0	0	0	7.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.1	0	0	0	0	0	29.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.2	0	0	0	0	0	0	26.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.3	0	0	0	0	0	0	0	44.50	0	0	0	0	0	0	0	0	0	0	0	0	0
R11.1	0	0	0	0	0	0	0	0	21.20	0	0	0	0	0	0	0	0	0	0	0	0
R11.2	0	0	0	0	0	0	0	0	0	49.40	0	0	0	0	0	0	0	0	0	0	0
R12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R13.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Rj/Pj	P27,2	P27,3	P28,1	P28,2	P28,3	P29,1	P29,2	P23,1	P23,2	P23,3	P23,4	P24,1	P24,2	P25,1	P25,2	P25,3	P33,1	P33,2	P33,3	P34,1	P34,2	P34,3
R1,1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
R1,2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R1,3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
R1,4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
R2,1	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	48,10	48,10	48,10
R2,2	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	144,30	144,3	144,30
R2,3	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	48,10	48,10	48,10
R2,4	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	144,30	144,3	144,30
R2,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48,10	48,10	48,10
R2,6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	144,30	144,3	144,30
R3,1	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	2,34	2,34	2,34
R3,2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,13	7,13	7,13
R3,3	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	2,34	2,34	2,34
R3,4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,13	7,13	7,13
R3,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,34	2,34	2,34
R3,6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,13	7,13	7,13
R4,1	0	0	-134	0	0	-109	0	0	0	0	0	20	0	100	0	0	1	0	0	1725	1898	1613
R4,2	-102	0	0	-106	0	0	-150	0	0	0	0	0	20	0	-100	0	-1	0	0	1725	1895	1613
R4,3	0	-99	0	0	-112	0	0	0	0	0	0	0	0	0	0	-100	0	-1	1	1725	1895	1613
R5,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6,1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6,2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6,3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6,4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7,1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7,2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7,3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8,1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8,2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	0	0
R8,3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9,1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9,2	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9,3	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10,1	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10,2	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10,3	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R11,1	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R11,2	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R12,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R13,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Constraints and Problem matrix for medium [illegible] farm at existing level of Technology, [illegible] District, 1979-80

Ri/Pj		P1.1	P1.2	P1.3	P1.4	P2.1	P2.2	P2.3	P2.4	P3.1	P3.2	P3.3	P3.4	P4.1	P4.2	P4.3	P5.1	P5.2	P5.3	P6.1	P6.2	P6.3
R1.1	1.82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
R1.2	2.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
R1.3	7.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R1.4	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R2.1	110	7.75	3.08	2.82	3.20	8.99	2.34	3.33	2.59	6.12	1.89	3.47	3.71	0	0	0	0	0	0	19.12	11.76	14.08
R2.2	439	[illegible]5.99	18.86	9.79	8.01	22.63	21.15	21.14	10.71	21.43	11.83	8.97	11.96	0	0	0	0	0	0	28.10	40.13	47.62
R2.3	110	9.70	5.47	3.07	4.39	7.78	4.14	4.14	5.04	7.79	8.67	5.37	4.40	0	0	0	0	0	0	0	0	0
R2.4	439	25.59	5.27	8.89	9.17	19.05	7.08	14.15	8.12	18.98	8.63	13.80	10.76	0	0	0	0	0	0	0	0	0
R2.5	110	7.31	3.09	3.68	3.10	5.87	2.34	3.42	4.17	5.61	1.75	3.13	4.70	0	0	0	0	0	0	0	0	0
R2.6	439	22.10	8.06	8.75	8.41	16.83	3.16	5.73	6.54	16.43	3.41	10.41	11.51	0	0	0	0	0	0	0	0	0
R3.1	32.70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14.69	15.41	18.50
R3.2	96.[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20.38	10.38	10.58
R3.3	35.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.4	100.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.5	36.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.6	105.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]
R4.1	4392	378	454	193	204	184	140	110	96	198	191	103	45	-1.45	0	0	-1.64	0	0	598	821	1009
R4.2	0	327	226	172	224	196	195	100	95	268	158	96	43	0	-1.56	0	0	-1.90	0	0	0	0
R4.3	0	572	158	130	206	135	39	28	76	236	117	101	49	0	0	-1.60	0	0	-2.0	0	0	0
R5.0	38.50	7.35	7.[illegible]	7.35	3.[illegible]	5.25	5.25	3.26	3.94	5.53	5.53	6.53	[illegible].94	0	0	0	0	0	0	0	0	0
R6.1	0	-5.70	-1.79	-1.17	-0.35	-1.04	-1.44	-3.05	-2.25	-2.17	-2.21	-1.97	-1.47	0	0	0	0	0	0	0	0	0
R6.2	0	-17.61	-3.98	-4.36	-3.27	-6.11	-2.50	-5.62	-4.22	-9.31	-2.88	-4.97	-3.71	0	0	0	0	0	0	16.05	17.07	[illegible]
R6.3	0	[illegible].67	-1.05	-1.10	-0.82	-2.13	-0.70	-1.48	[illegible].11	-2.47	-0.77	-1.31	-0.98	0	0	0	0	0	0	0	0	0
R6.4	0	-2.43	-0.56	-0.57	-0.42	-1.12	-0.30	-0.78	-0.58	-1.29	-0.37	-0.68	-0.51	0	0	0	0	0	0	0	0	0
R7.1	187	442	260	0	0	146	139	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0
R7.2	187	405	217	0	0	182	124	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0
R7.3	187	261	145	0	0	105	39	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0
R8.1	0	0	0	0	0	0	0	0	0	189	120	0	0	0	0	0	-1	0	0	0	0	0
R8.2	0	0	0	0	0	0	0	0	0	165	186	0	0	0	0	0	0	-1	0	0	0	0
R8.3	0	0	0	0	0	0	0	0	0	178	179	0	0	0	0	0	0	0	-1	0	0	0
R9.1	6.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.98	8.34	17.19
R9.2	5.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.3	5.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.1	5.00	0	0	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0
R10.2	5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.3	3.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R11.1	3.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R11.2	3.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R12.0	0	1	1	0	-1	1	1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
R13.0	0	0	0	0	0	0	0	0	0	1	1	0	-1	0	0	0	0	0	0	0	0	0

Contd............

R1/P1	P6.	P6.7	P7.1	P7.2	P7.3	P7.4	P9.1	P9.2	P8.1	P17.0	P18.0	P20.1	P19.0	P12.2	P15.1	P10.0	P27.1	P27.2	P27.3	P28.1	P28.2	P28.3
R1.1	0	0	1	1	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0
R1.2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
R1.3	1	0	0	0	1	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0
R1.4	0	1	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
R2.1	0	0	22.10	22.75	0	0	16.65	[illegible]	24.25	0	138	14.82	51.39	0	0	11.29	0	0	0	0	0	0
R2.2	0	0	80.07	98.53	0	0	84.16	0	9.88	0	220	14.82	25.00	0	0	13.41	0	0	0	0	0	0
R2.3	28.86	0	0	0	27.69	0	0	22.00	0	40.60	73.40	4.94	83.00	30.97	23.65	0	0	0	0	0	0	0
R2.4	48.06	0	0	0	40.41	0	0	78.60	0	89.29	0	14.82	15.00	80.67	80.65	0	0	0	0	0	0	0
R2.5	0	19.34	0	0	0	34.33	0	0	0	0	65.20	4.94	36.00	0	0	0	0	0	0	0	0	0
R2.6	0	33.17	0	0	0	58.71	0	0	0	0	220	14.82	39.00	0	0	0	0	0	0	0	0	0
R3.1	0	0	24.10	23.98	0	0	14.40	0	4.48	0	0	1.64	20.75	0	0	27.51	0	0	0	0	0	0
R3.2	0	0	7.41	7.41	0	0	3.27	0	0	0	0	4.94	14.82	0	0	0	0	0	0	0		0
R3.3	29.?4	0	0	0	29.96	0	0	19.76	0	16.18	0	1.64	0	18.35	13.16	0	0	0	-	0	0	0
R3.4	16.88	0	0	0	11.48	0	0	3.28	0	0	0	4.94	0	0	0	0	0	0	0	0	0	0
R3.5	0	17.42	0	0	0	47.10	0	0	0	0	0	1.64	0	0	0	0	0	0	0	0	0	0
R3.6	0	19.90	0	0	0	23.71	0	0	0	0	0	4.94	0	0	0	0	0	0	0	0	0	0
R4.1	0	0	1841	987	0	0	1440	0	611	0	6036	1778	1300	0	0	137	-96	0	0	-134	0	0
R4.2	1288	0	0	0	1253	0	0	1298	0	4666	0	1778	1000	1013	695	0	0	-102	0	0	-106	0
R4.3	0	1169	0	0	0	1046	0	0	0	0	6036	1778	904	0	0	0	0	0	-99	0	0	-112
R5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.1	0	0	0	0	0	0	0	0	0	0	0	340	0	0	0	0	0	0	0	0	0	0
R6.2	10.82	10.48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.3	0	0	18.28	22.02	15.21	29.70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.4	0	0	0	0	0	0	13.25	10.58	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0
R9.2	17.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0
R9.3	0	14.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
R10.1	0	0	18.20	20.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0
R10.2	0	0	0	0	18.21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-1	0
R10.3	0	0	0	0	0	29.73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1
R11.1	0	0	0	0	0	0	23.87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R11.2	0	0	0	0	0	0	0	11.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R13.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Ri/Pj	P29.1	P29.2	P33.1	P33.2	P33.3	P34.1	P34.2	P34.3	P23.1	P23.2	P23.3	P23.4	P25.1	P25.2	P25.3	P24.1	P24.2	P24.3	P26.0
R1.1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
R1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R1.3	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
R1.4	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
R2.1	0	0	0	0	0	48.1	48.1	59.3	-1	0	0	0	0	0	0	0	0	0	0
R2.2	0	0	0	0	0	114.3	114.3	179.9	0	-1	0	0	0	0	0	0	0	0	0
R2.3	0	0	0	0	0	48.1	48.1	59.3	0	0	-1	0	0	0	0	0	0	0	0
R2.4	0	0	0	0	0	114.3	114.3	179.9	0	0	0	-1	0	0	0	0	0	0	0
R2.5	0	0	0	0	0	48.1	48.1	59.3	0	0	0	0	0	0	0	0	0	0	0
R2.6	0	0	0	0	0	114.3	114.3	179.9	0	0	0	0	0	0	0	0	0	0	0
R3.1	0	0	0	0	0	2.34	2.34	2.34	0	0	0	0	0	0	0	-1	0	0	0
R3.2	0	0	0	0	0	7.13	7.13	7.13	0	0	0	0	0	0	0	0	0	0	0
R3.3	0	0	0	0	0	2.34	2.34	2.34	0	0	0	0	0	0	0	0	-1	0	0
R3.4	0	0	0	0	0	7.13	7.13	7.13	0	0	0	0	0	0	0	0	0	0	0
R3.5	0	0	0	0	0	2.34	2.34	2.34	0	0	0	0	0	0	0	0	0	-1	0
R3.6	0	0	0	0	0	7.13	7.13	7.13	0	0	0	0	0	0	0	0	0	0	0
R4.1	-109	0	1	0	0	850	895	903	0	0	0	0	-100	0	0	20	0	0	0
R4.2	0	-150	-1	1	0	850	895	903	0	0	0	0	0	-100	0	0	20	0	40
R4.3	0	0	0	-1	1	850	895	903	0	0	0	0	0	0	-100	0	0	20	0
R5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
R6.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R11.[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[illegible]	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R13.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Constraints and Problem matrix for large synthetic Farm at existing level of technology, Bangalore District, 1979-80

Ri/Pj		P1.1	P1.2	P1.3	P1.4	P2.1	P2.2	P2.3	P2.4	P3.1	P3.2	P3.3	P3.4	P4.1	P4.2	P4.3	P5.1	P5.2	P5.3	P6.1	P6.2	P6.3	P6.4
R1.1	2.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
R1.2	5.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1
R1.3	2.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R1.4	2.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R2.1	141.10	3.09	2.92	2.99	2.04	1.96	2.23	2.14	0.88	2.76	2.32	2.67	2.200	0	0	0	0	0	0	7.40	21.87	13.17	14.50
R2.2	423.30	15.21	12.82	12.35	9.226	6.82	10.98	8.82	3.64	13.66	11.45	11.03	8.27	0	0	0	0	0	0	18.92	53.83	58.26	46.87
R2.3	141.10	5.61	4.85	4.85	3.84	2.80	4.01	3.45	1.43	5.01	4.03	4.33	3.26	0	0	0	0	0	0	0	0	0	0
R2.4	423.30	8.95	8.95	12.35	9.26	6.82	6.39	6.82	3.64	7.99	7.99	11.03	8.27	0	0	0	0	0	0	0	0	0	0
R2.5	141.10	5.89	5.89	5.89	1.42	1.60	1.35	1.35	0.88	1.69	1.59	1.69	2.00	0	0	0	0	0	0	0	0	0	0
R2.6	423.30	10.06	10.06	8.57	6.44	6.82	7.18	6.12	5.64	8.98	8.98	7.65	8.25	0	0	0	0	0	0	0	0	0	0
R3.1	54.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.85	11.57	6.59	6.80
R3.2	162.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.55	7.79	6.59	1.30
R3.3	56.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.4	169.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.5	56.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R3.6	169.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R4.1	5634	664	345	285	151	131	109	113	41	195	185	109	146	-1.43	0	0	-1.60	0	0	666	1075	1746	805
R4.2	0	593	430	315	162	175	150	148	43	279	247	126	166	0	-1.56	0	0	-1.90	0	0	0	0	0
R4.3	0	579	450	202	100	165	140	140	36	252	233	69	98	0	0	-1.60	0	0	[illegible]	0	0	0	0
R5.0	38.78	4.65	4.65	4.65	2.49	3.32	3.32	3.32	2.49	4.15	4.15	4.15	2.49	0	0	0	0	0	0	0	0	0	0
R6.1	0	-7.94	-2.05	-3.14	-3.31	-3.90	-2.95	-0.70	-2.14	-6.21	-2.39	-3.80	-2.99	0	0	0	0	0	0	0	0	0	0
R6.2	0	-14.98	-5.34	-5.30	-5.58	-7.10	-6.04	-4.70	-5.18	-13.52	-7.77	-10.0	-7.71	0	0	0	0	0	0	28.0	28.52	24.70	19.35
R6.3	0	-2.25	-0.80	-0.80	-0.84	-1.66	-0.90	-0.75	-0.79	-2.07	-1.19	-1.50	-1.15	0	0	0	0	0	0	0	0	0	0
R6.4	0	-1.50	-0.50	-0.56	-0.71	-0.50	-0.49	-0.52	-1.35	-0.78	-1.50	-1.50	-1.15	0	0	0	0	0	0	0	0	0	0
R7.1	275	580	282	0	0	108	95	0	0	0	0	0	0	-1	0	0	0	0	0	0	[illegible]	0	0
R7.2	275	513	359	0	0	143	125	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0
R7.3	275	500	384	0	0	132	118	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0
R8.1	0	0	0	0	0	0	0	0	0	133	116	0	0	0	0	0	-1	0	0	0	0	0	0
R8.2	0	0	0	0	0	0	0	0	0	176	154	0	0	0	0	0	0	-1	0	0	0	0	0
R8.3	0	0	0	0	0	0	0	0	0	160	146	0	0	0	0	0	0	0	-1	0	0	0	0
R9.1	31.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10.00	12.88	37.05	9.36
R9.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.1	14.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R11.1	7.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R12.0	0	1	[illegible]	0	-1	1	1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R13.0	0	0	0	0	0	0	0	0	0	1	1	0	-1	0	0	0	0	0	0	0	0	0	0

Contd. ....

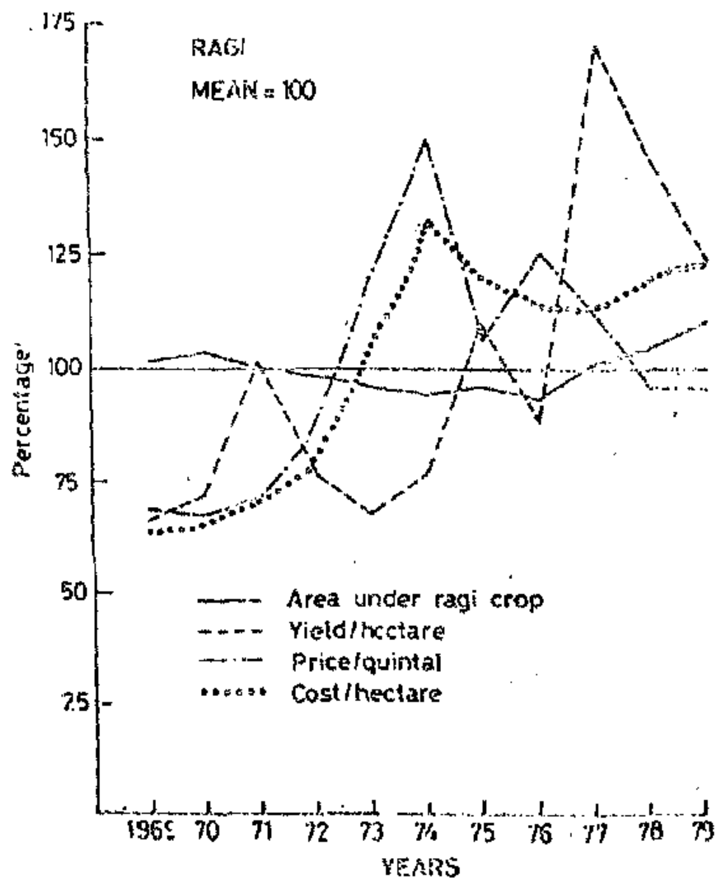
R3/F3	P6.5	P6.7	P7.1	P7.2	P7.3	P7.4	P9.1	P8.1	P10.0	P15.1	P17.0	P18.0	P22.1	P24.1	P24.2	P24.3	P23.1	P23.2	P23.3
R1.1	0	0	1	1	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0
R1.2	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
R1.3	1	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0
R1.4	0	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0
R2.1	0	0	15.24	17.89	0	0	9.32	19.50	6.72	0	0	81.87	14.82	0	0	0	<1	0	0
R2.2	0	0	40.23	41.14	0	0	16.80	31.06	37.93	0	0	34.70	14.82	0	0	0	0	<1	0
R2.3	28.36	0	0	0	31.34	0	0	0	0	0	35.60	81.60	4.94	0	0	0	0	0	<1
R2.4	58.58	0	0	0	71.10	0	0	0	0	0	134.27	12.35	14.82	0	0	0	0	0	0
R2.5	0	35.45	0	0	0	36.41	0	0	0	28.74	0	37.05	4.94	0	0	0	0	0	0
R2.6	0	85.34	0	0	0	90.50	0	0	0	121.60	0	39.45	14.82	0	0	0	0	0	0
R3.1	0	0	29.36	29.36	0	0	5.07	13.47	11.62	0	0	20.75	1.64	<1	0	0	0	0	0
R3.2	0	0	3.83	3.83	0	0	0	0	0	0	0	14.82	4.94	0	0	0	0	0	0
R3.3	14.00	0	0	0	17.96	0	0	0	0	0	24.70	0	1.64	0	<1	0	0	0	0
R3.4	13.17	0	0	0	26.3[illegible]	0	0	0	0	0	11.29	0	4.94	0	0	0	0	0	0
R3.5	0	27.32	0	0	0	17.15	0	0	0	14.37	0	0	1.64	0	0	<1	0	0	0
R3.6	0	11.62	0	0	0	26.35	0	0	0	0	0	0	4.94	0	0	0	0	0	0
R4.1	0	0	1693	880	0	0	853	283	120	0	0	18317	239	20	0	0	0	0	0
R4.2	1544	0	0	0	1275	0	0	0	0	0	4793	5475	239	0	20	0	0	0	0
R4.3	0	1299	0	0	0	2417	0	0	0	4495	0	10842	239	0	0	20	0	0	0
R5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.1	0	0	0	0	0	0	0	0	0	0	0	0	63.23	0	0	0	0	0	0
R6.2	34.85	25.86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.3	0	0	77.59	54.81	33.58	22.60	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.4	0	0	0	0	0	0	30.36	0	0	0	0	0	0	0	0	0	0	0	0
R7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.2	33.76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.3	0	18.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.1	0	0	32.78	27.84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.2	0	0	0	0	33.58	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R10.3	0	0	0	0	0	40.33	0	0	0	0	0	0	0	0	0	0	0	0	0
R11.1	0	0	0	0	0	0	10.56	0	0	0	0	0	0	0	0	0	0	0	0
R12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R13.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

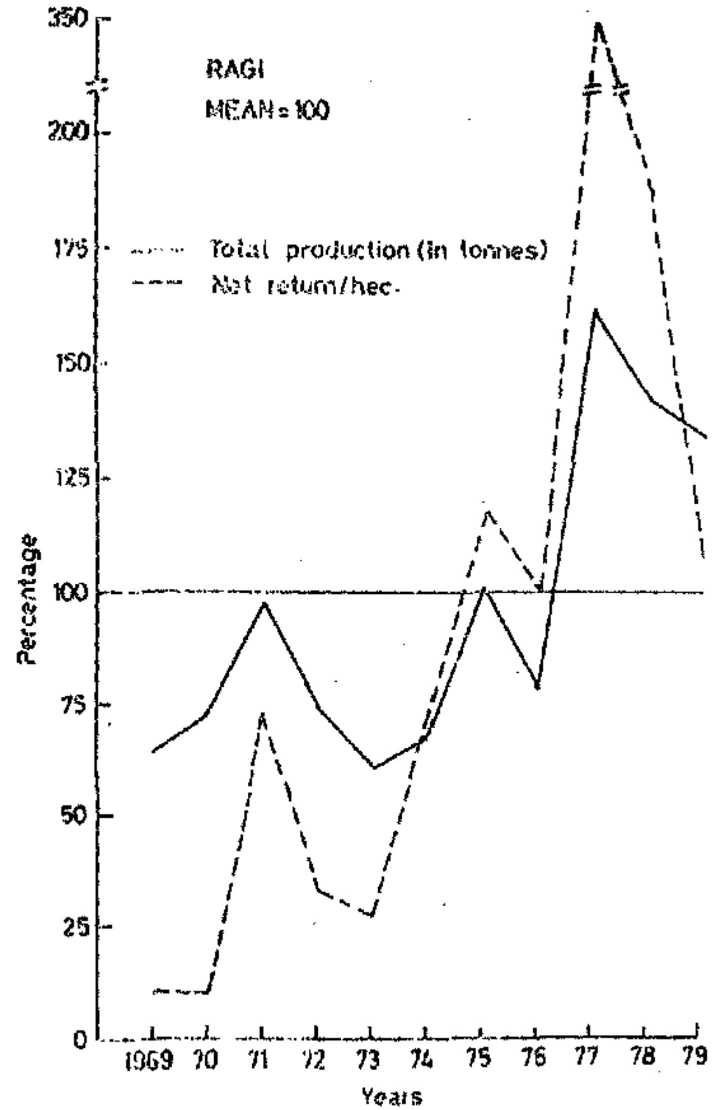
Cont ....

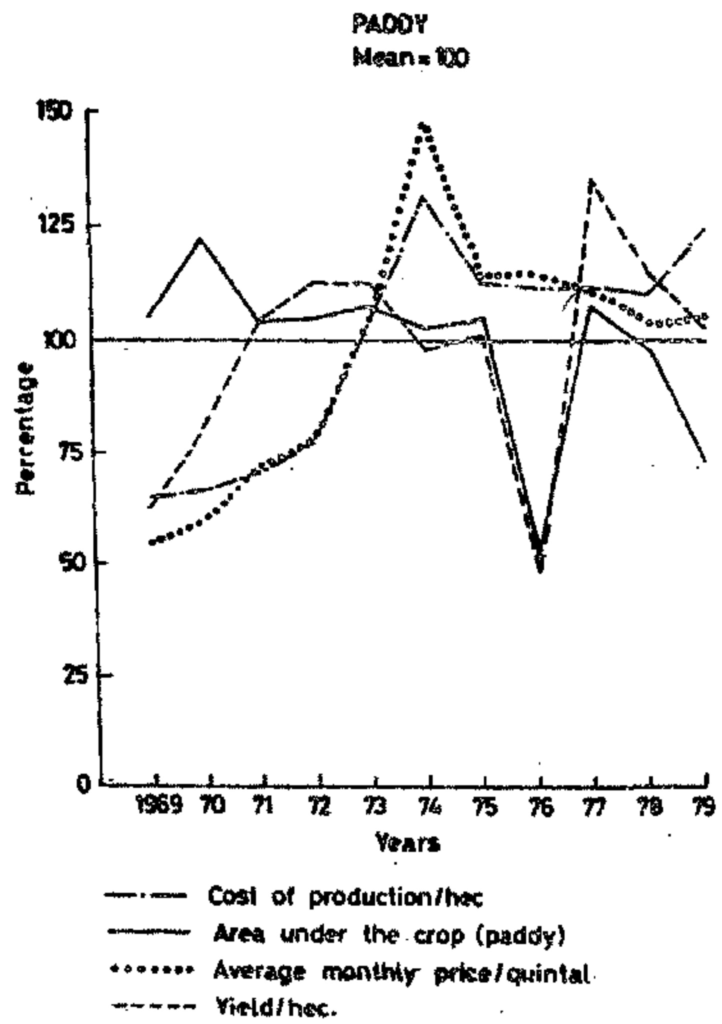
RJ/FJ	P23.4	P25.1	P25.2	P25.3	P26.0	P27.1	P27.2	P27.3	P28.1	P28.2	P28.3	P29.1	P33.1	P33.2	P33.3	P34.2	P34.3
R1.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
R1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R1.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
R1.4	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0	0	1	1
R2.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	113	106
R2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	339	318
R2.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	113	106
R2.4	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	339	318
R2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	113	106
R2.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	339	318
R3.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.34	2.34
R3.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.13	7.13
R3.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.34	2.34
R3.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.13	7.13
R3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.34	2.34
R3.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.13	7.13
R4.1	0	-100	0	0	0	-95	0	0	-134	0	0	-129	1	0	0	4842	5277
R4.2	0	0	-100	0	0	0	-102	0	0	-106	0	0	-1	1	0	4842	5277
R4.3	0	0	0	-100	40	0	0	-99	0	0	-112	0	0	-1	1	4842	5277
R5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.2	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0
R6.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R6.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R7.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R8.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R9.1	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0
R9.2	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0
R9.3	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0
R10.1	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0
R10.2	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0
R10.3	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0
R11.1	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0
R12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R13.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

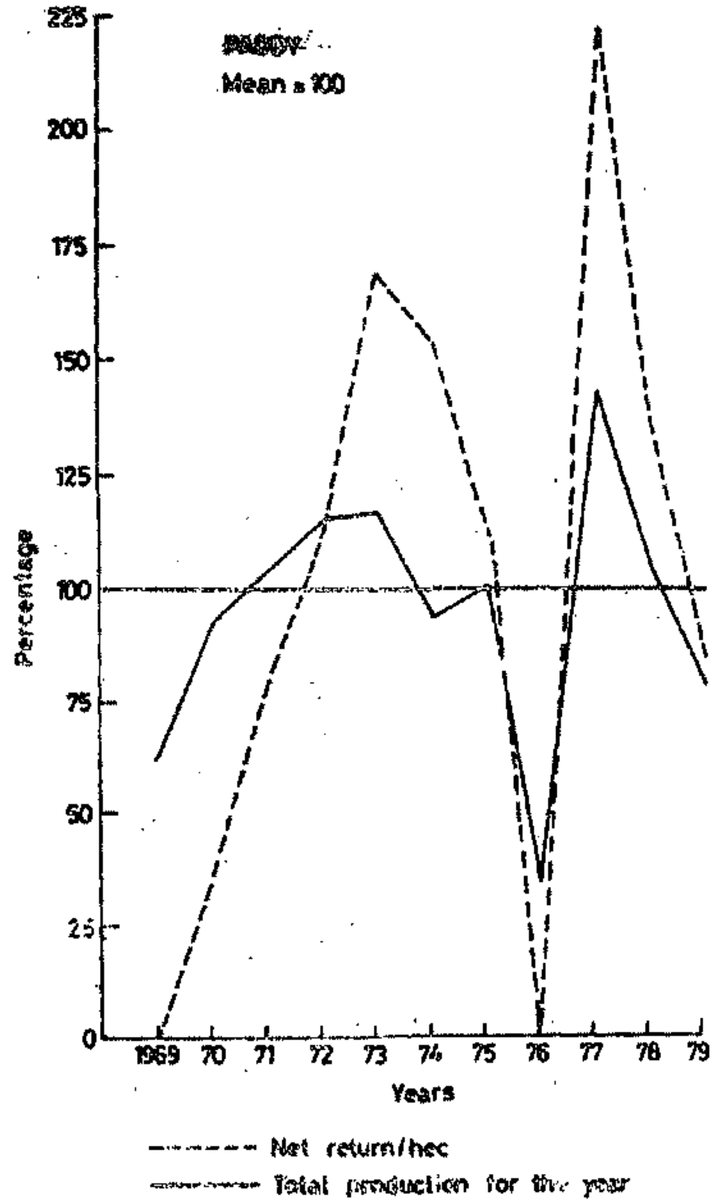
Variation in Area, Yield price cost, total production and net return of some important farm enterprise - Crop, Dairy and Sericulture

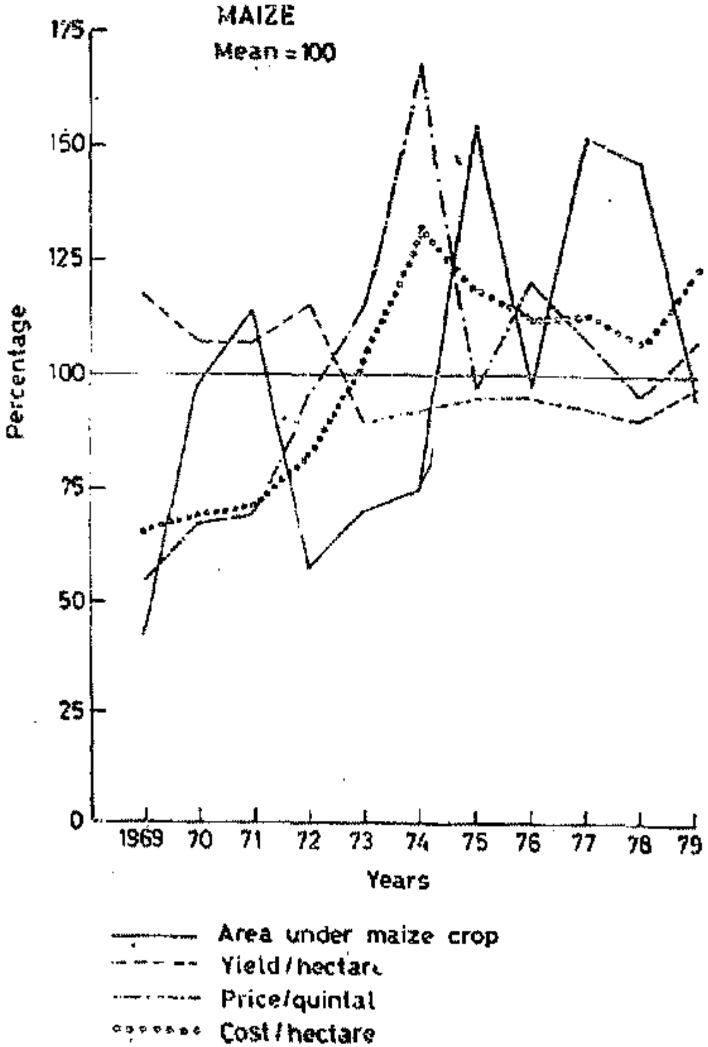
Figures 1 - 20

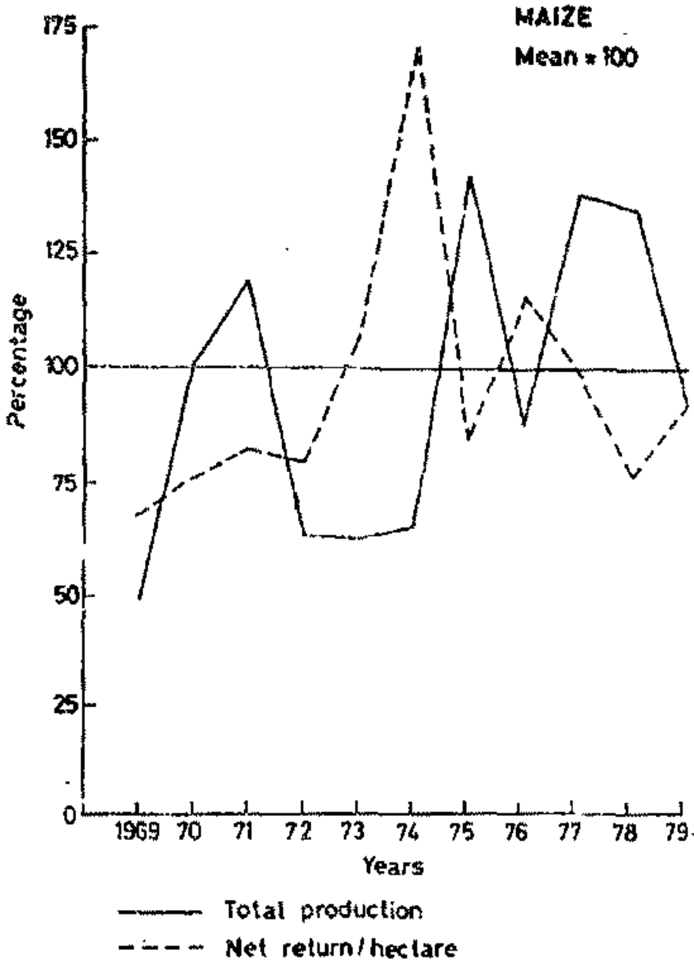

RAGI
MEAN = 100
Area under ragi crop
Yield/hectare
Price/quintal
Cost/hectare
Percentage
YEARS

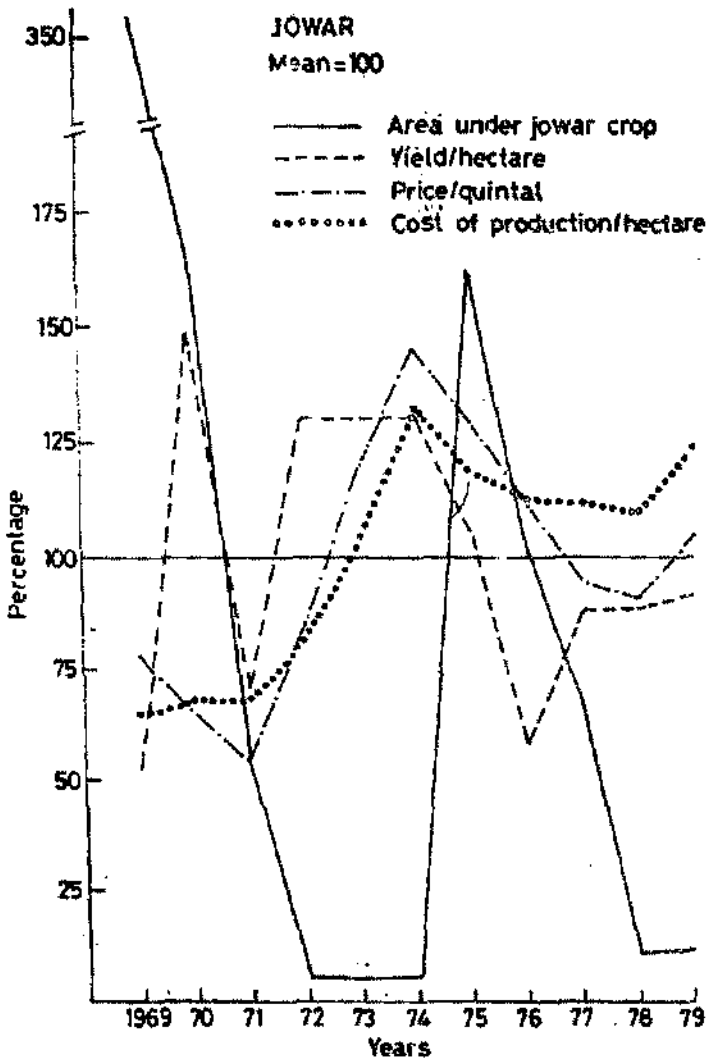

RAGI
MEAN = 100
Total production (in tonnes)
Net return/hec.
Percentage
Years


PADDY
Mean = 100
Percentage
150
125
100
75
50
25
0
1969 70 71 72 73 74 75 76 77 78 79
Years
Cost of production/hec
Area under the crop (paddy)
Average monthly price/quintal
Yield/hec.

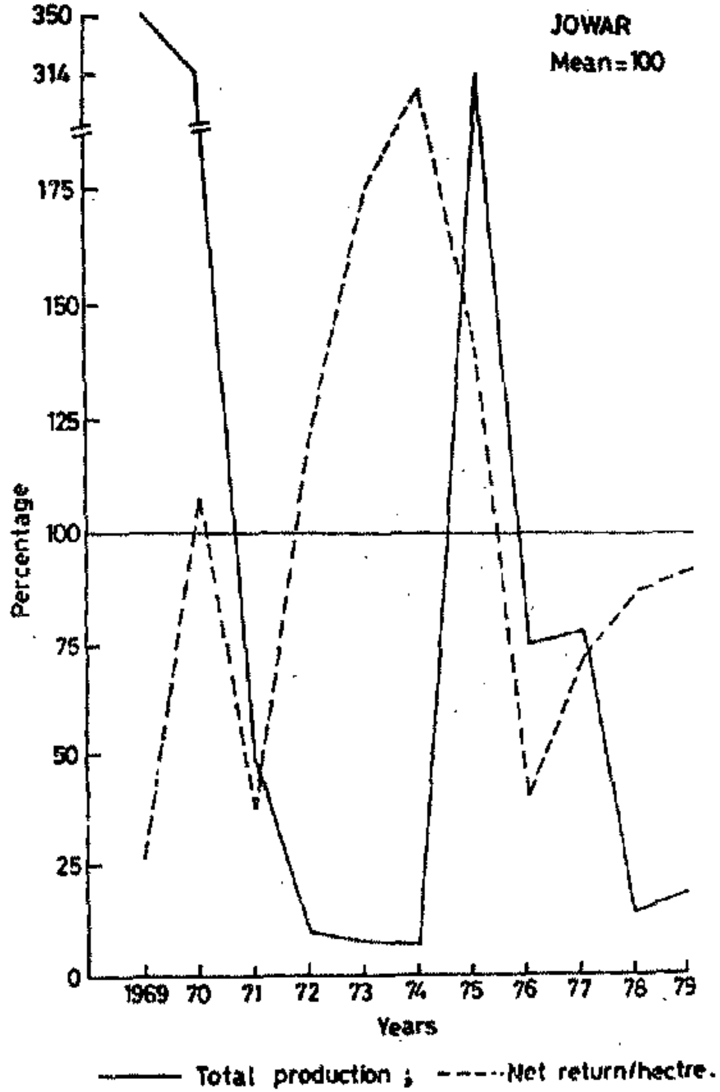

PADDY
Mean = 100
Percentage
225
200
175
150
125
100
75
50
25
0
1969 70 71 72 73 74 75 76 77 78 79
Years
Net return/hec
Total production for the year


MAIZE
Mean = 100
Percentage
175
150
125
100
75
50
25
0
1969 70 71 72 73 74 75 76 77 78 79
Years
Area under maize crop
Yield/hectare
Price/quintal
Cost/hectare

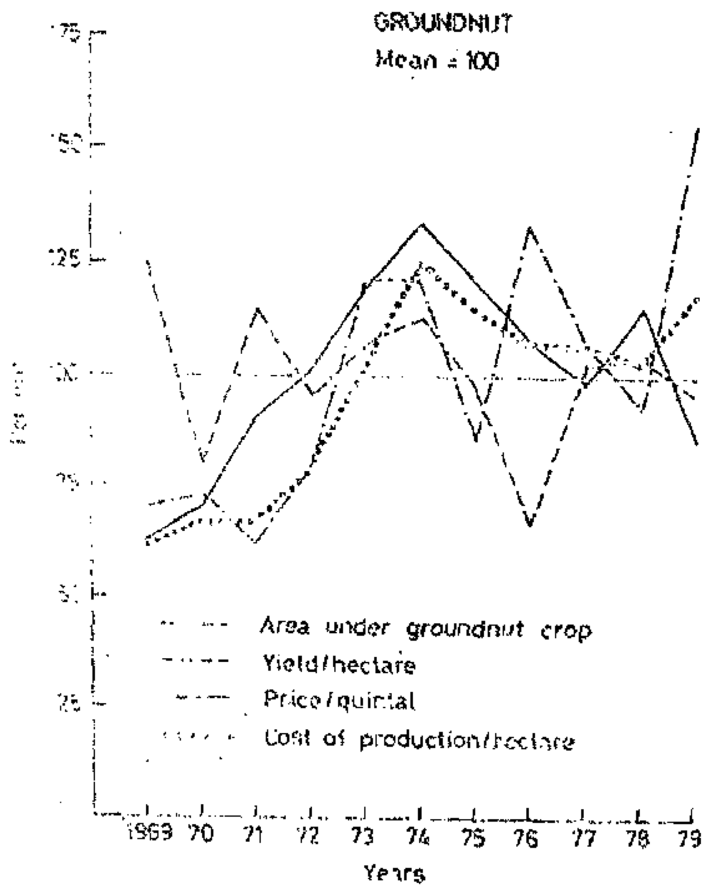

MAIZE
Mean = 100
Percentage
175
150
125
100
75
50
25
0
1969 70 71 72 73 74 75 76 77 78 79
Years
Total production
Net return/hectare

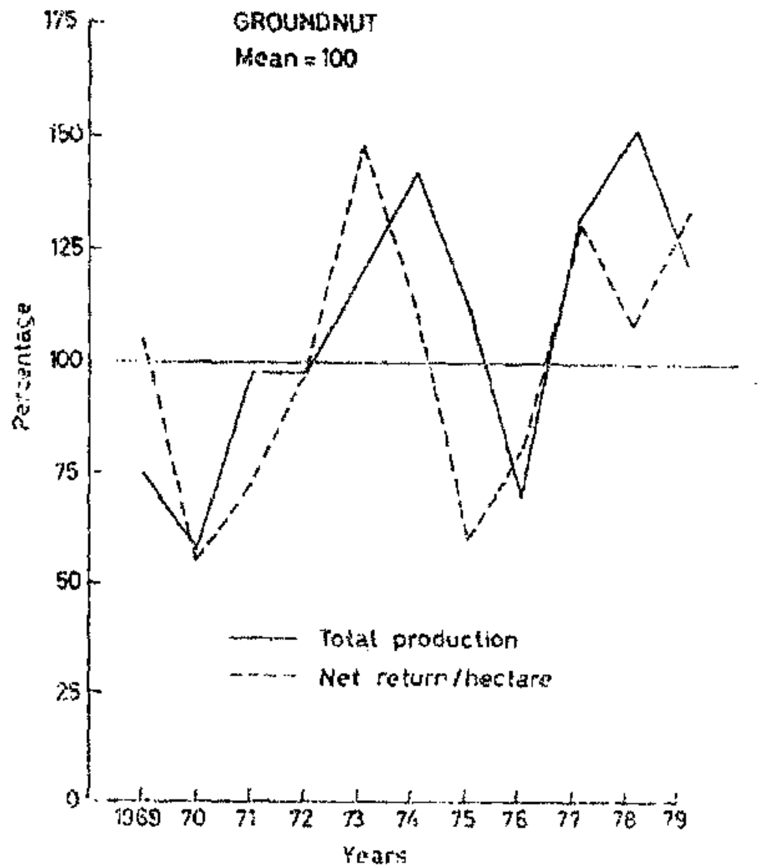


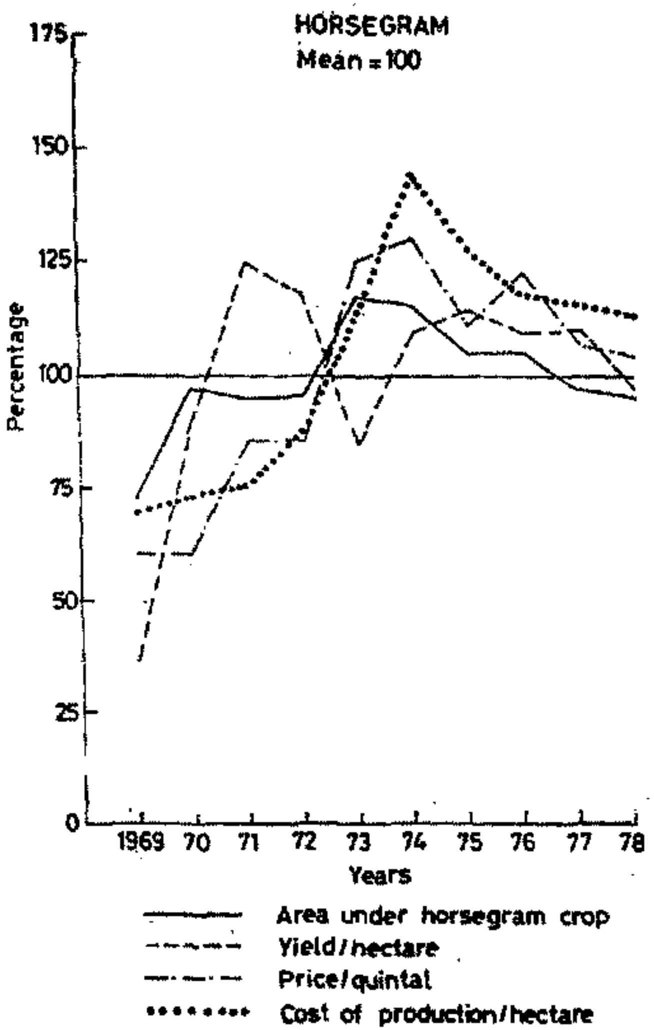
JOWAR
Mean=100
Area under jowar crop
Yield/hectare
Price/quintal
Cost of production/hectare
Percentage
Years
350
175
150
125
100
75
50
25
1969 70 71 72 73 74 75 76 77 78 79

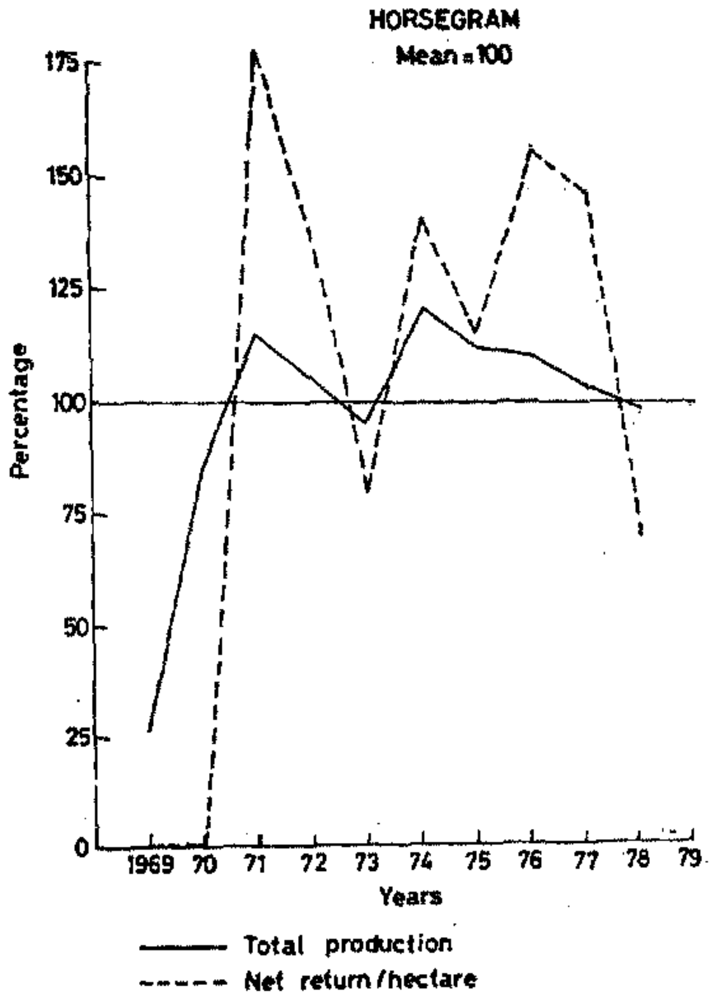


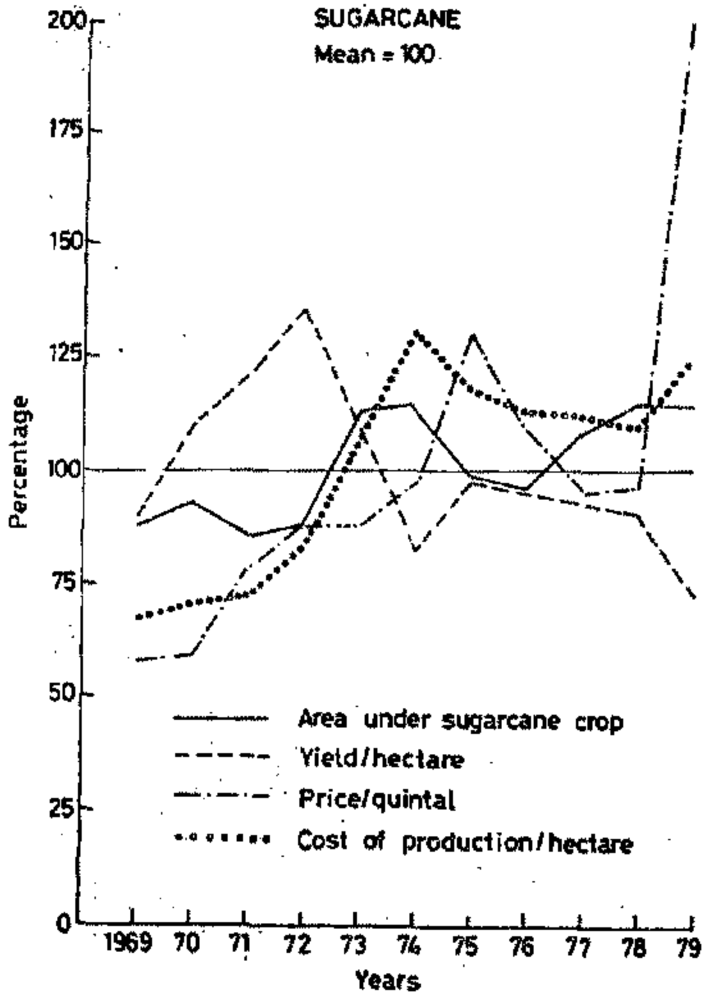
JOWAR
Mean=100
Percentage
Years
350
314
175
150
125
100
75
50
25
0
1969 70 71 72 73 74 75 76 77 78 79
Total production ; Net return/hectre.

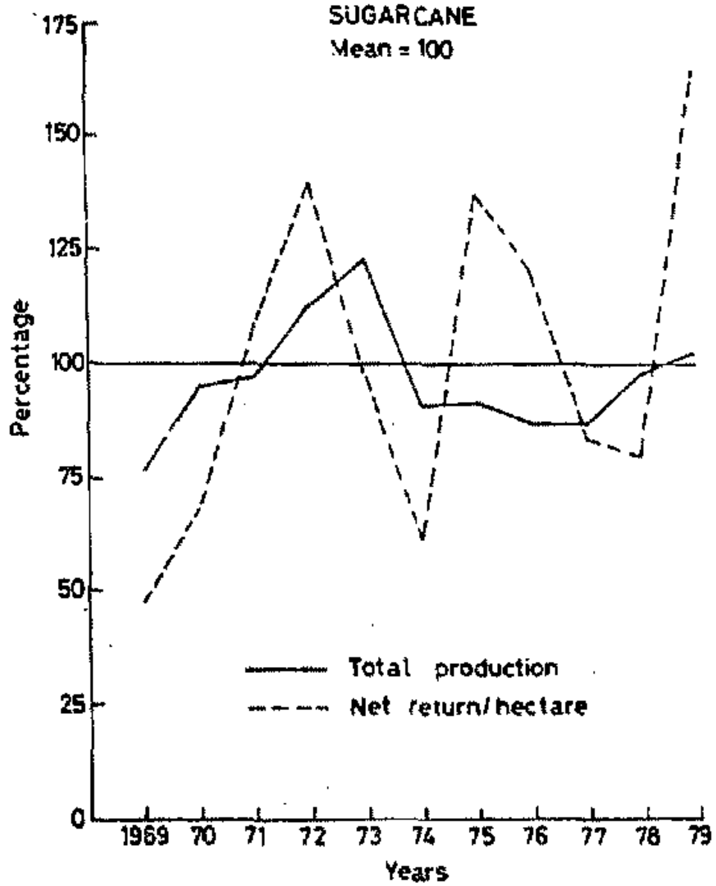

GROUNDNUT
Mean = 100
Area under groundnut crop
Yield/hectare
Price/quintal
Cost of production/hectare
1969 70 71 72 73 74 75 76 77 78 79
Years

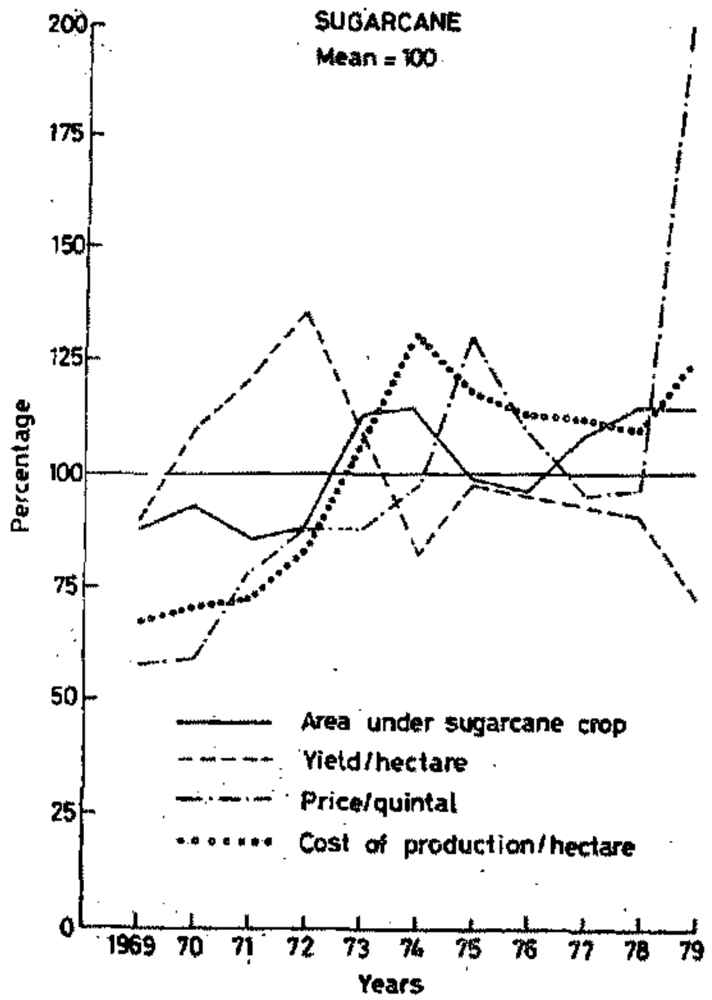

GROUNDNUT
Mean = 100
175
150
125
100
75
50
25
0
Percentage
Total production
Net return/hectare
1969 70 71 72 73 74 75 76 77 78 79
Years

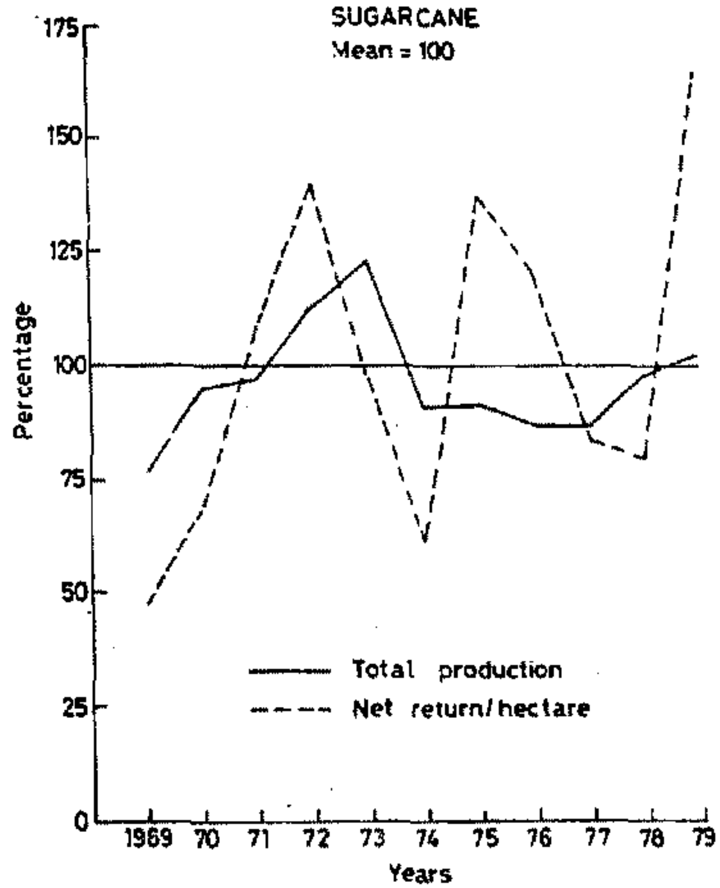

HORSEGRAM
Mean = 100
175
150
125
100
75
50
25
0
Percentage
1969
70
71
72
73
74
75
76
77
78
Years
Area under horsegram crop
Yield/hectare
Price/quintal
Cost of production/hectare

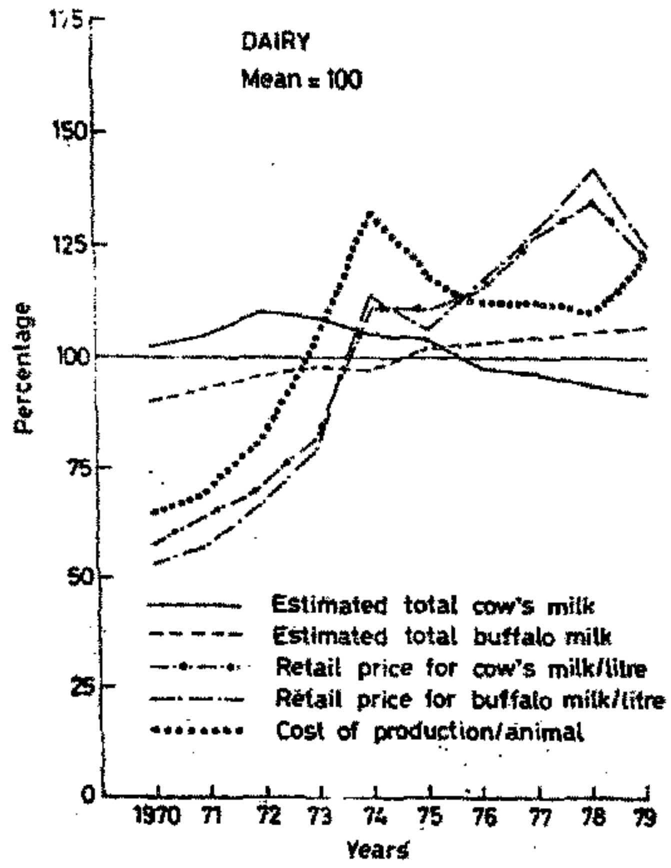

HORSEGRAM
Mean = 100
175
150
125
100
75
50
25
0
Percentage
1969
70
71
72
73
74
75
76
77
78
79
Years
Total production
Net return/hectare

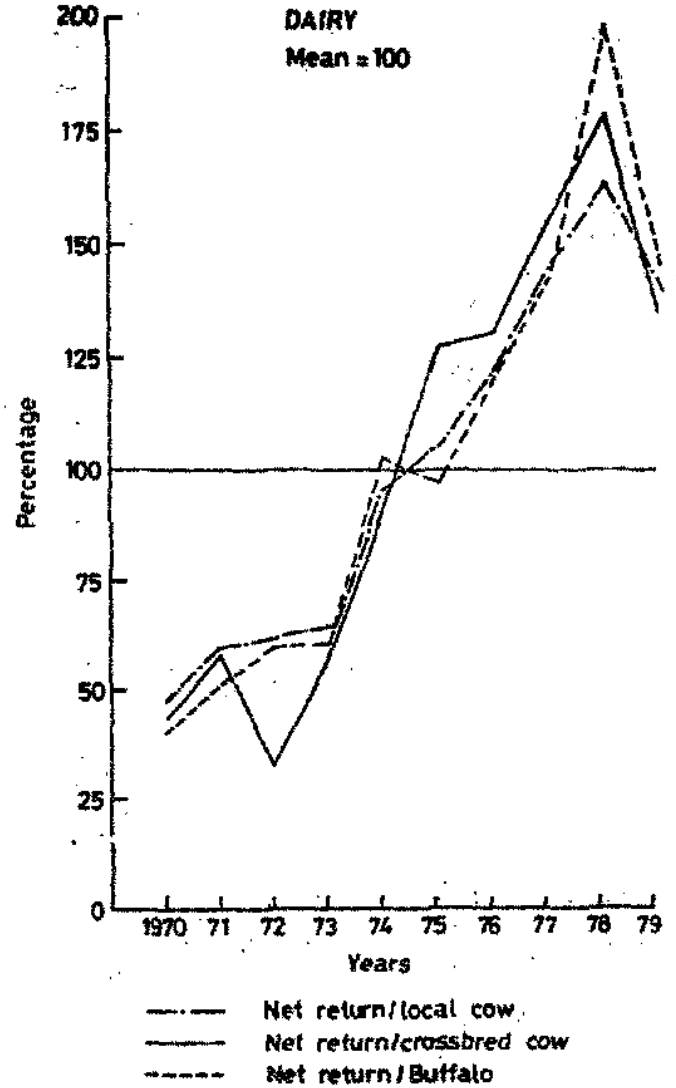

SUGARCANE
Mean = 100
Percentage
Years
Area under sugarcane crop
Yield/hectare
Price/quintal
Cost of production/hectare
0
25
50
75
100
125
150
175
200
1969
70
71
72
73
74
75
76
77
78
79

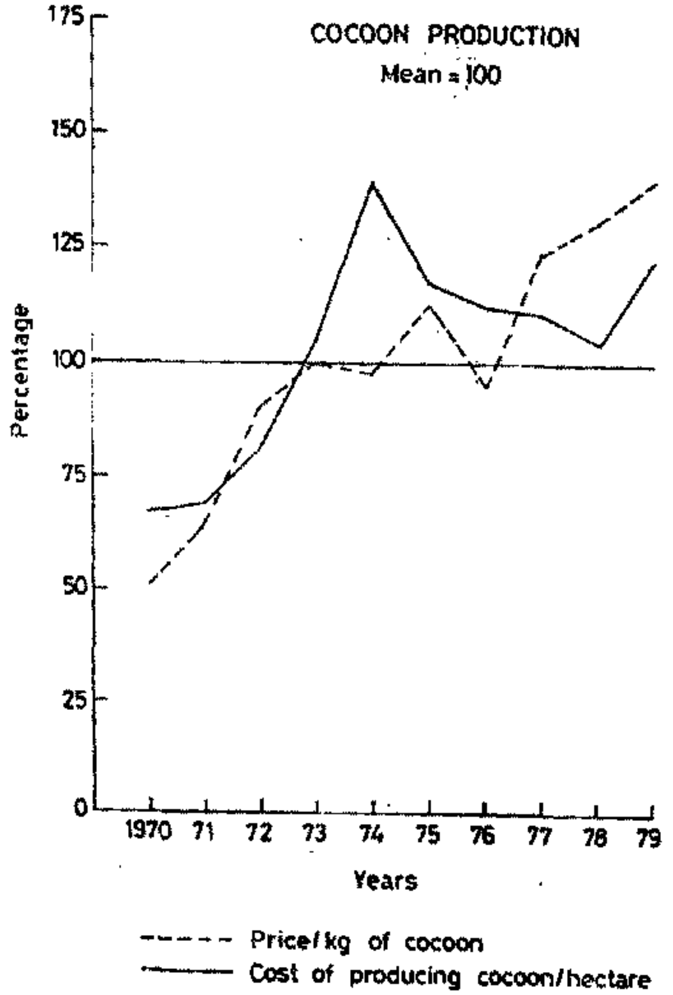

SUGARCANE
Mean = 100
Percentage
Years
Total production
Net return/hectare
0
25
50
75
100
125
150
175
1969
70
71
72
73
74
75
76
77
78
79

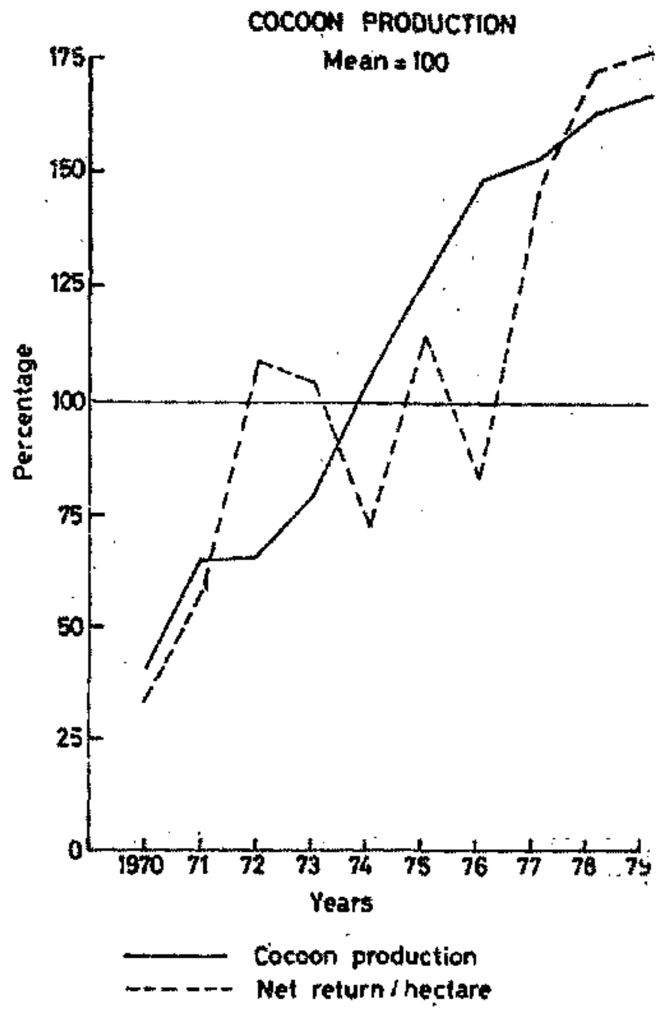

SUGARCANE
Mean = 100
Percentage
200
175
150
125
100
75
50
25
0
1969 70 71 72 73 74 75 76 77 78 79
Years
Area under sugarcane crop
Yield/hectare
Price/quintal
Cost of production/hectare


SUGARCANE
Mean = 100
Percentage
175
150
125
100
75
50
25
0
1969 70 71 72 73 74 75 76 77 78 79
Years
Total production
Net return/hectare


DAIRY
Mean = 100
Percentage
Years
Estimated total cow's milk
Estimated total buffalo milk
Retail price for cow's milk/litre
Retail price for buffalo milk/litre
Cost of production/animal


DAIRY
Mean = 100
Percentage
Years
Net return/local cow
Net return/crossbred cow
Net return/Buffalo


COCOON PRODUCTION
Mean = 100
Percentage
175
150
125
100
75
50
25
0
1970 71 72 73 74 75 76 77 78 79
Years
Price/kg of cocoon
Cost of producing cocoon/hectare


COCOON PRODUCTION
Mean = 100
Percentage
175
150
125
100
75
50
25
0
1970 71 72 73 74 75 76 77 78 79
Years
Cocoon production
Net return / hectare

APPENDIX - X

Annual rainfall in Bangalore District
(1969-1979)

Year	Rainfall (mm)
1969	914
1970	904
1971	791
1972	948
1973	1048
1974	916
1975	1375
1976	674
1977	1069
1978	942
1979	953
Average	957.6
Coefficient of variation	58.04