CURRENT STATUS, PROBLEMS AND PROSPECTS OF DAIRY FARMS IN DHARMAPURI DISTRICT

Thesis submitted in part fulfilment of the requirements of Doctor of Philosophy in Animal Husbandry Economics to the Tamil Nadu Veterinary and Animal Sciences University, Madras.

by
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Dedicated to my beloved mother

CERTIFICATE

This is to certify that the thesis entitled **"CURRENT STATUS, PROBLEMS ND PROSPECTS OF DAIRY FARMS IN DHARMAPURI DISTRICT"**submitted part fulfilment of the requirements for the degree of **DOCTOR OF PHILOSOPHY ANIMAL HUSBANDRY ECONOMICS** to the Tamil Nadu Veterinary and Animal ciences University, Madras is a record of *bona fide* research work carried out by **hiru. K. Rajendran** under my supervision and guidance and that no part of this esis has been submitted for the award of any other degree, diploma, fellowship or ther similar titles or prizes and that the work has not been published in part or full any scientific or popular journal or magazine.

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ABSTRACT

CURRENT STATUS, PROBLEMS AND PROSPECTS OF DAIRY FARMS IN DHARMAPURI DISTRICT

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An attempt to study the current status, problems and prospects of dairying in Dharmapuri district, Tamil Nadu was made with the objectives of examining the existing status and costraints in dairying to suggest alternative plans.

A sample of 360 farmers were selected from 3 blocks, post stratified, which resulted in 24.72 per cent of landless, 24.17 per cent of marginal farmers, 27.50 per cent of small farmers and 23.61 per cent of large farmers, from whom the cross section data related to the fiscal year 1995-96 were gathered.

The structure of milch animal composition revealed that buffaloes were preferred among landless and marginal farmers, while the large farmers preferred only cross bred cows.

The total fixed cost and total variable cost per milch animal per lactation for buffaloe was lower as compared to cross bred cow. The interest on investment was the major component of the fixed cost and feed cost accounted for more than 70 per cent of total variable cost. Of the feed cost, the concentrates formed 24 per cent.

The net return was highest for buffaloes in all the categories of farmer in block I where as in case of cross bred cows, the highest net income of Rs.3786.43 was realised in landless category of block II. But the cost of milk production was lowest in cross breds compared to buffaloes in all the categories and in all the three blocks. It was also found that large farmers rank first in milk production to the tune of 10.20 litres per day.

Consumption of dry fodder was more in block II and the use of concentrate was found to increase with increase in size of holdings in all the blocks. The consumption of green fodder was to more in cross bred cows in marginal farmer category of block I. The hired and permanent labour use increased with increase in size of holding.

Stochastic frontier production function fitted, indicated the goodness of fit with coefficients of multiple determination more than 0.69 in block I for all categories of farmers. The elasticity coefficient of concentrate is statistically significant for all categories except small farmers and the coefficient of cost of health care was significant in landless category. The breed dummy variables in landless and small farmers were significant indicating the chances for cross bred cows.

In block II, the elasticity coefficient of concentrate was significant which implied the significant contribution of concentrate to milk yield. The significant negative sign for the coefficient of dry fodder calls for reallocation of various inputs to maximise the milk yield and the 't' test indicated the existence of constant returns to scale in marginal and small farmers.

In block III, the elasticity coefficient of concentrate was significant in landless, small and large farmers, also found significance of breed dummy in all categories except in large farmers. The excessive use of human labour was also found in landless and marginal farmers in the maintenance of milch animals. The sum of production elasticities ranged from 0.19 to 0.06 indicated the existence of decreasing return to scale in all the categories of farmer.

The technical efficiency ranged from 0.21 to 0.80 and the mean efficiency value of farms for the blocks I, II and III were 0.45, 0.45 and 0.52 respectively. More than 50 per cent of the farmers were operating below their respective mean level efficiency.

Optimal plan developed for landless in block I, indicated that inclusion of one cross bred cow in place of buffaloe resulted in increased net income of 37.80 per cent and for marginal farmers, 1.62 acres Tapioca + 0.58 acre Sugarcane + 2 buffaloes would result in net income increased to 24.64 per cent. The optimal plan for small farmers could be 2.70 acres Tapioca + 1.84 acres Sugarcane + 2 buffaloes which increased the net income to 23.71 per cent and for large farmers, 3.4

acres Tapioca + 4.12 acres Sugarcane + 0.69 acre Cotton + 2 buffaloes which increased the net income at Rs.3025.

In block II, the optimal plan for landless was similar to the former except a 10 per cent increase in concentrate and green fodder shifted to cross bred cow resulting in increased net return by 5.14 per cent. In case of marginal farmers, the optimal allocation of land for tapioca was 1.85 acres with two cross bred cows increased the net income to 43.90 per cent, where as the plan for small farmers' with 2.15 acres Tapioca +0.41 acre Groundnut +1.64 acres Cotton +2 buffaloes increased the net income to 39.51 per cent and for large farmers 2.70 acres Tapioca +3.40 acres Sugarcane +1.50 acres Cotton +2 buffaloes increased the net income to 23.29 per cent.

In block III, all the categories of farmer shifted to cross bred cows and increased net income to 20.89 per cent.

The major constraints in milk production for block I ranked in the order of low price of milk, low productivity, high investment, inadequate infrastructure for milk marketing, costly veterinary expenses and for block II the constraints were in the order of inadequate input, low productivity, low price of milk, high investment, repeat breeding, high feed cost, inadequate infrastructure for milk marketing, frequently become sick and costly veterinary expenses. The various problems in the block III were high feed cost, high investment, low price of milk, inadequate infrastructure for milk marketing, low productivity, inadequate input, costly veterinary expenses, frequently become sick and repeat breeding.

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INTRODUCTION

CHAPTER I

INTRODUCTION

Setting

(Livestock enterprises including dairying are often suggested by the planners and policy makers as an alternative instrument for poverty alleviation and rural development in drought prone areas. Despite land reforms and improvements in institutional setup, the overall environment has not been always conducive to progressive agriculture, necessitating a diversification that gives high priority to integration of livestock into the crop farming system. Better utilisation of farm resources thereby needs a favourable relationship between cropping and livestock production. Various enterprises like dairying, poultry keeping, sheep and goat rearing at optimal level can effectively be integrated into the farming system.) Of these enterprises, dairy component contributes a major share towards national income. Milk assures supply of the most critical nutrients to the vulnerable sections of the society, besides ensuring a regular and fair income to the producer. For the reasons stated, the improvement in milk production is a central part of the drive for food security and economic growth throughout much of the developing world.

Inspite of having three quarters of human population and two-third of the world's cattle, the efficiency, performance and contribution of livestock towards agricultural production and in turn to national income are deplorably low in developing countries. The per capita milk availability in the developing countries is therefore less than one-tenth of what is available in the developed countries. Since the developing countries are expected to double their human population in the next generation, the real need and demand for milk is very large, and the deficit is likely to become steadily more acute (FAO, 1987).

Indian agriculture today is characterized by decreasing farm size, increasing number of operational holdings, higher degree of fragmentation and declining contribution of agriculture to Gross Domestic Product. The share of agricultural workforce to total workforce is not declining and that the absolute number of people dependent on agriculture for employment and income, is increasing owing to a low absorptive capacity for labour in industry (Swaminathan, 1989). This calls for expansion of emerging high demand sub-sectors, chiefly dairying, horticulture, fisheries, poultry and forestry (Reserve Bank of India, 1989).

Further, land is the most limiting factor in raising income and employment in rural areas through crop production alone. With about 45 per cent land under cultivation in India, the land-man ratio would be 0.15 ha by the end of this century. The small and marginal farmers account for nearly three-fourth of land holdings in the country, operating over one-fourth of the total area. They have been left out to suffer badly from under-employment. It is, therefore, essential that landless and small farmers are engaged in livestock enterprises that would yield regular flow of employment throughout the year even in vagaries of drought and flood (Deoghare, 1993).

Eventhough the share of agriculture in Gross Domestic Product has been declining, the value of output from livestock is showing an increasing trend. The contribution of livestock to the agricultural sector stands nearly at 24 per cent. Of which the dairy sub sector accounts for nearly two-third of the total livestock contribution. The track record of the dairy sector is thus impressive by any yardstick. The growth of the agricultural sector has been marginally higher than the growth of population.) But the growth of dairy sector has been at an encouraging 5 per cent (Patel, 1993).

India, with 53.5 million tonnes annual milk production, ranks second next only to the U.S.A. in the world, where the milk has also emerged as the second largest agricultural-allied product. Ninety five per cent of milk in India is produced by the animals which are fed with crop residues like paddy straw, wheat straw, maize and millet stovers combined with concentrates prepared solely out of agricultural by- products like oil cakes, molasses, rice polishes, etc., showing the importance of dairy enterprise in the Indian agricultural system , in particular and national economy in general.

Milk production in India, which was almost stagnant between 1947 and 1970 (20 million tonnes) with an annual growth rate of just one per cent, started responding to the market stimulus and inputs from 1970 onwards, registering a growth rate of six per cent per annum. The milk production in 1990 had gone up to 51 million tonnes and today, the annual milk production stands at 53.5 million tonnes. As a result of increased milk production, the per capita consumption of milk, which had increased from 107 g in 1950 to 132 g in 1970, had gone upto 173 g in 1990. The plausible low and high estimates of annual growth in demand for milk are around four per cent and six percent respectively. Based on these estimates the effective demand for milk in India could be some where between 70 million tonnes and 80 million tonnes in 2000 AD. The per capita availability of milk at 70 million tonnes of annual production in 2000 AD will be about 192 g/day and that at 80 million tonnes will be 219 g/day which is very close to the nutritional standard based on the Indian diets (Mudgal, 1995).

Fortunately, there prevails an economic symbiosis between crop and cattle production. In the coming years foodgrains production has to be increased to meet the growing population's demand, to build up a safe level of buffer stock, to save valuable foreign exchange and to encourage domestic production. Dairy sector would need to be encouraged, not at the cost of cereal production but by fully exploiting the complementary, supplementary, synergistic and symbiotic relationship of raising animals with crop production (Patel, 1993).

Problem Focus

Increase in agricultural production over time can be attained either by bringing more area under cultivation or by cultivating the same area more than once in a given cropping year or by increasing the output through adoption of improved innovations or by combining all these techniques together. But, the scope for increasing agricultural production by bringing more area under cultivation is constrained by the scarcity of cultivable land, irrigation and capital for investment. Similarly, increasing the output by intensifying the cropping pattern may also be constrained by the water resource and capital investment.

The other area that needs attention in increasing the farm income will be that of strengthening livestock activities, more specifically dairying. But, in a largely market oriented economy like India, success of efforts to promote dairying in rural area depends to a large extent on efficient management of the enterprise by the farmers to reduce the cost and to gain economic advantage in a market where they are simply price takers. This highlights the need for investigation on output performance in dairy production with a view to identify the constraints in management of dairy farms and solutions thereof.

The National Commission on Agriculture (1976) have rightly pointed out that the rearing of good quality milch animals as a subsidiary occupation along with arable farming, if adopted with application of modern technology and provision of marketing facilities, would bring a better life to the farming community.

Crop cultivation in India is subjected to a high degree of risk and uncertainty and provides only seasonal, irregular and uncertain incomes to the farmer. With a view to mitigate the risk and uncertainties of income from crop enterprise and reduce the time lag between input costs and returns, it is essential that the farmers incorporate such enterprise in their production programme which yield regular and evenly distributed income throughout the year and not subjected badly to vagaries of nature.

The need for land-saving agriculture and grain-saving animal husbandry can be met only by further improvements in technology. In a backward peasant proprietorship economy where small holdings predominate, the integration of different crop and livestock enterprises becomes so strong that any drastic change in an enterprise upsets the very functioning of the other enterprise, atleast in the short-run because the output of one enterprise is used as an input in the other enterprise and thus establishing a balancing link. In such circumstances management of farm business does not merely aim at maximisation of profit by endeavouring to equalise the resource efficiencies through the mechanism of optimum allocation but would rather see that an enterprise with less efficient use of resources survives to support an enterprise with more efficient use of resources and making enterprise integration as a technical necessity.

So in all, the farming system specifically refers to a crop combination or enterprise mix in which products and/or the by-products of one enterprise serves as an input for the other enterprise.)

In this context, this study considers the integrated farming system as a system interwoven with crop and dairy enterprises.

Objectives

Overall objective of the study is to prepare an optimal crop and livestock plan with a view to help agricultural development and to make it to serve as a model for similar area planning elsewhere. The specific objectives are to:

i) examine the existing status of dairying;

ii) analyse the constraints in dairying with reference to factors and products; and

iii) suggest alternative plans to augment income and employment.

Hypotheses

i) The cost of milk production and resource use pattern may vary among different categories of milk producers.

ii) Farm income could be increased through optimal mix of crop and dairy enterprises.

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Scope of the Study

This study would help the farmers in reducing the undesirable costs and to increase resource use efficiency in milk production. The outcome of the study would help the policy makers in drawing appropriate policies for dairy development. The alternative plans and the results of this study may aid the planners, policy makers, extension agencies and non-governmental organisations in planning efficient strategies for improving, updating and modernising the traditional form of crop cultivation and dairy farming.)

Limitations of the Study

This study has been confined to a particular agroclimatic region. The relevant data for the study have been collected for the period 1995-96 by personal interview with the dairy farmers in the study area. Since the data collection by survey method is likely to have recall bias, suitable cross checks have been made to minimise errors. Since this study confined to a particular geographical region of the state, Dharmapuri district, the results of the study are therefore not to be generalised. If at all generalised, it should be done with caution and that too for similar agro-climatic conditions only.

Organisation of the Thesis

The study has been divided into the following chapters:

Chapter I	:	The problem setting, objectives, hypotheses, scope and limitations of the study are presented.
Chapter II	:	Concepts used in the present study and review of earlier studies are discussed.
Chapter III	:	Design of the study and techniques of analysis are discussed.
Chapter IV	:	The general description and farming conditions of the study area-are presented.
Chapter V	:	The results of the study are discussed and interpreted.
Chapter VI	:	The summary and conclusion with policy implications are presented.

CONCEPTS AND REVIEW

CHAPTER II

CONCEPTS AND REVIEW

A clear cut knowledge of various concepts is very essential for successful conduct of any research work. Knowledge of past work done on the related studies will be of much use on clearly understanding and specifying the concepts and tools of analysis as applicable in the present study. In this chapter, an attempt is made to present a brief review of earlier works and various concepts of this study. For better under standing, the concepts and review are discussed under the following major headings.

1. Cost of Milk Production
2. Studies on Cost of Milk Production
3. Integrated Farming
4. Resource Productivity
5. Programming
6. Constraints in Milk Production

1. Cost of Milk Production

The cost of production was defined as the sum of costs of all inputs which aided the production.

Singh and Sirohi (1973) concluded that total annual expenditure on productive livestock comprises of annual overhead cost consisting of depreciation and interest on fixed capital (investment), cost of feed, value of human labour associated with the maintenance of livestock and interest on working capital. They are of the opinion that the values of farmyard manure available should be deducted from the annual expenditure on livestock.

Ramasamy *et al.* (1981) calculated gross cost as the sum of cost on green fodder, dry fodder, concentrates, labour, interest and depreciation, veterinary care and miscellaneous. The value of manure was deducted from the gross cost to get net cost which was divided by the average milk production to get the cost of milk production per litre.

Singh and Singh (1981) included feed cost, family and paid labour, miscellaneous expenses, depreciation and interest on fixed capital and insurance premium in gross cost. The gross cost was deducted from the value of milk and manure to get net income. The imputed value of family labour was added to the net income to get the family labour income.

Gopalakrishnan and Mohanlal (1985) considered interest on investment and working capital, insurance cost, miscellaneous expenses, depreciation on livestock, equipment and shed, cost of feed and fodder, labour cost, veterinary aid and mineral salts under gross cost.

Gilbert and Gouin (1993) considered three main elements in calculating the cost of milk production: total net costs (feed costs and all expenses directly associated with rearing and replacement of animals in the dairy herd and maintaining dairy cows), labour time and property costs. Costs associated with the administration of the quota system, subsidies and other government assistance, and income generated by sales of cows, bulls and calves were deducted to determine the total cost/lit of milk produced.

Rajendran and Prabaharan (1993) worked out the cost of production per litre of buffalo milk, cross bred cow milk and desi cow milk for different categories of farmers by dividing the total cost of production by the total quantity of milk produced.

Devaraj and Gupta (1994) computed the per day maintenance cost of cows as well as of buffaloes in different seasons by adding up all types of costs incurred in rearing the animal. The cost per litre of milk production for an animal was worked out by dividing the per day maintenance cost by daily milk yield. Net returns were obtained by subtracting the cost of milk production from the sale price of milk for cows and buffaloes separately.

Ahir and Singh (1994) used different cost concepts viz., cost A (out of pocket expenses which included costs of feeds, hired labour, veterinary and miscellaneous charges, interest on working capital and depreciation on animal, shed and equipments), Cost B (cost A plus interest on fixed capital), cost C defined as Cost B plus imputed value of family labour and Cost D which is the total cost and included Cost C plus 10 per cent of Cost A (the managerial cost) while computing cost of milk production.

Singh and Sharma (1994) classified the costs into operational and fixed costs where the operational costs included the costs of feeds and fodders, human labour cost and miscellaneous expenditure on minor repairs of cattle shed and stores, dairy equipments, water and electricity charges, cost of health cover and breeding fees etc., and fixed costs which composed of depreciation on animal, cattle shed and stores, dairy equipments and interest on fixed capital. In the case of animals, no depreciation was charged upto third lactation.

Sangu (1995) worked out the cost of milk production for buffaloe, desi cow and cross bred cow by adding both fixed and variable costs. Fixed cost included the interest on capital invested, depreciation on buildings, equipment and machinery and on electrical and water installation, cost on labour (home and permanent) and electricity charges and the variable cost included the cost on dry fodder, green fodder, concentrate, veterinary charges and miscellaneous cost.

Shiyani *et al.* (1995) calculated the per day cost and returns in buffaloe and cow by considering the cost on green fodder, dry fodder, concentrates,labour and miscellaneous expenditure as variable cost and interest on fixed capital and depreciation as fixed cost. The fixed and variable costs were added to findout the total cost of milk production.

In this study, to calculate the cost of production per litre of milk, the gross cost was divided by the total milk production.

For the present study the cost of production is defined as the sum of fixed cost which included the interest on fixed capital,depreciation on buildings,equipments and machinery and insurance and variable cost to include the feed cost (green fodder, dry fodder and concentrate), medicine and veterinary charges, wages paid to the permanent, family and casual labour and miscellaneous cost.

2. Studies on Cost of Milk Production

Waghmare and Diskalkar (1975) found that in buffaloe milk production, concentrates accounted for 31.95 per cent of the total cost followed by family labour at 27.42 per cent and depreciation and interest on fixed capital which together accounted for 21.64 per cent.

Rao and Singh (1980) stated that overall investment was the highest on the crossbred animals followed by cattle sheds and stores. With regard to cost structure, it was observed that feed and human labour were the major items of cost, accounting to 54 and 19 per cent of the total cost for all cross breds respectively.

Reddy and Mathur (1980) worked out the cost of milk production for the cross bred cows and the graded buffaloes maintained at an organised dairy farm and found that the cost of daily maintenance of an animal to be Rs.5.50 and Rs.5.53 for cows and buffaloes respectively. The cost per kg. of milk was found to be Re.0.99 and Rs.1.32 respectively in the same order. The cross bred cows showed better performance in all respects except the annual profit per milch animal was found to be high incase of buffaloes.

Poole (1983) found that a higher proportion of family farms in the United Kingdom include dairy as a component enterprise. On comparisons of efficiency, costs and returns of specialist and family dairy farms in England and Wales, showed very small differences in efficiency in favour of specialist farms but higher profits from the family farms.

Sharma *et al.* (1986) noted that expenditure incurred by urban farms, semi urban farms and rural farms were 70 to 74 per cent, 51 to 62 per cent and 43 to 56 per cent on feed, 12 to 16 per cent, 15 to 24 per cent and 21 to 28 per cent on labour and 8 to 9 per cent, 17 to 20 per cent and 18 to 23 per cent on fixed costs respectively.

Bal *et al.* (1987) concluded that dry fodder, concentrates, human labour and green fodder accounted for 14.70, 16.76, 19.50 and 25.50 per cent of the total maintenance cost. The fixed cost which included the allowances for interest and depreciation on milch animals, cattle shed and equipments accounted for 20 per cent of the total maintenance cost.

Gupta (1987), in his study on cost of milk production of cross bred and indigenous milch animals revealed that Holstein-Friesian cow was the most profitable animal followed by Jersey cow and Murrah buffaloes. The cost of milk production was minimum in rainy season followed by winter and summer seasons in case of Murrah buffaloes while for Jersey, Brown - Swiss and desi cows the cost was minimum in rainy season followed by summer and winter seasons. The high yielder was the Holstein-Friesian followed by Jersey and Brown swiss. Maximum cost per litre of milk was for desi cow followed by Murrah buffaloe. Feed cost was more than 59 per cent of the total cost of milk production for all type of milch animals.

Gangwar and Sastry (1988), in their study on economics of buffaloe milk production concluded that feed constituted the main cost of maintenance and milk yields were lowest in the rainy season although costs of production were highest.

Kumar and Gupta (1988) found that the cost of feed constitutes the major part of the maintenance cost. Despite the lower cost of milk production, per day maintenance cost of cross bred cow was found to be the highest as compared to buffaloe and local cow, and where they opined that only large and upper medium farmers could afford to maintain the crossbred cows because of their high maintenance costs.

Pandey *et al.* (1991) found that the cost of fodder, food and labour accounted for 22-28, 16-19 and 14-16 per cent of the total costs for the winter, summer and rainy seasons respectively. Considering all farm animals the cost of production was Rs.7.89 - Rs.9.24 per kg. milk and Rs.3.37 - Rs.3.67 per kg. based only on the costs of the lactating animals.

Rao *et al.* (1991) stated that in milk production of buffaloes, feed and fodder costs together accounted for 71 per cent of the total cost, of which concentrates constituted the major share and human labour accounted for about nine per cent.

Goswamy and Rao (1992) found that expenditure on fodder and concentrates formed the major share in the total cost of milk production of the sample farms. Input-output ratio was the highest in large farms followed by medium farms.

Samithisawad (1992) concluded that the cost on feed grains which accounted for 63 per cent as the major cost of milk production.

Tailor *et al.* (1992) calculated the economics of milk production in Surti buffaloes and found that the average cost of milk production was Rs.3.34 per kg. Of the total production cost, dry fodder accounted for the highest (27.69 per cent) which is closely followed by production ration (26.21 per cent) and miscellaneous expenses (5.93 per cent). Of the total production cost, 85.12 per cent was spent on feeding and of the total cost incurred during intercalving period, 68.16 and 31.84 per cent expenditure was spent during milking and dry period respectively. On an average net maintenance cost per buffaloe during intercalving and milking period was Rs.6767.44 and Rs.4618 respectively, after deducting income from dung. The expenditure on feeding during milk and dry period was 75.68 and 78.46 per cent of the total maintenance-cost respectively.

Ram *et al.* (1993) analysed the economics of milk production and reported that the per litre cost of milk production was Rs.3.07 and it was found to be higher in winter when compared to rainy season. Feed and fodder formed the major component,accounting for 64.40 per cent of the total cost, followed by labour (14.9

per cent), fixed cost (13.58 per cent) and miscellaneous recurring expenses (7.32 per cent).

Deoghare and Bhattacharyya (1994) examined the economics of buffalo milk production and found that the expenditure on fodder and concentrates formed the major share in the total cost of milk production. Net income per buffaloe per year was highest for large farms followed by medium farms. Considering cash costs and depreciation the average cost per litre of buffalo milk was Rs.3.71. Overall, crop production contributed more than 83 per cent to total net farm income while the contribution of buffaloe enterprises was around 17 per cent.

Sharma and Singh (1994) calculated the costs and returns for different breeds of dairy animals with different categories of farmers and found that the average annual maintenance cost of cross bred cows, local cows, graded Murrah buffaloes and local buffaloes to be Rs.3624.55, 1981.95, 4161.00 and 2584.20 respectively, yielding a gross income of Rs.5099.48, 2013.32, 6069.62 and 3385.65. The operational cost was approximately 85 per cent of total cost where as the fixed costs accounted only for 15 per cent of total costs.

Singh *et al.* (1994), in their study on economics of buffaloe milk production revealed that the daily mean total cost per milch buffalo was Rs.20.43 and the gross cost of milk production per litre was Rs.3.67 (Rs.4.09, 3.63 and 3.41 in summer, rainy and winter seasons respectively). Costs decreased with increase in herd size, and net returns per litre of milk increased from Re.0.26 for 1-2 buffaloes to Re.0.85 for 7-11 buffaloes (over all mean Re.0.50). Feeds and fodder accounted for about 60 per cent of the total costs of production and labour costs for about 17 per cent.

Rao and Singh (1995) conducted a study on impact of Operation Flood on the economics of milk production in Guntur district of Andhra Pradesh and found that feeds and fodders formed the major component of gross expenditure in both the extension and control areas. The beneficiary households spend a higher amount on feeds and fodders per dairy animal as compared with that on the non-beneficiary households. A relatively higher net income and lower cost of milk production on the beneficiary house holds as compared with those on the non beneficiary households indicated the positive impact of Operation Flood programme in the study area.

Shah and Singh (1995) conducted a comparative economic study of costs and returns in cross bred cow and found that expenditure on feeds and fodder, purchase of animals and labour charges were relatively higher in urban areas than in rural areas. This resulted in higher total cost per lactation in urban areas (Rs.5760) than in rural areas (Rs.5403). However, total returns as well as net profit were higher in urban areas showing the superiority of urban dairy herds run on commercial lines as compared to cross bred cows maintained in a subsistence economy setting in rural areas.

3. Integrated Farming

Mixed farming is practiced by Indian farmers from time immemorial. However, a clear cut definition for the term mixed farming has not emerged till recently.

Bhattacharjee (1961) defined mixed farming as a combination of crop and livestock enterprises with the objective of maximising the gross income from the farm as a whole. According to him, a farm of mixed type in nature, atleast 10 ɔer cent of its gross income must be contributed by livestock activities, the upper limit ɔeing 49 per cent. It offers scope for full utilisation of family labour and permanent ꞉stablishment which would otherwise remain idle in lean season.

National Commission on Agriculture (1976) defined mixed farming as a system ɔf farming that combined field crop production with one or more of other enterprises ike growing fruits, vegetables, raising cattle, sheep, goats, pigs, poultry, fishery, bee ꞉eeping and sericulture.

Singh and Sharma (1987) conducted a study to evaluate the potential of increasing ncome and employment on small farms with different farming systems. Data employed ɔertained to a sample of 67 small farmers from the mid western region of Uttar 'radesh, among whom five farming systems were identified as operating. It was ɔbserved that a maximum potential for increasing income in the above existing levels xisted in crop + dairy + goat farming followed by crop + goat farming and crop + lairy + poultry farming in that order. A purely crop farming system proved to be he poorest choice in terms of income and employment generation.

Singh and Saini (1988) observed that the integration of improved technology of ꞉rop and dairy enterprise had a positive and significant impact on the level of income ɩnd employment in all the categories of farms. It was also observed that the benefit ɩccruing from combination of crop and dairy enterprises would be more in small and marginal farmers as compared to the large farmers.

Deoghare *et al.* (1990) reported that livestock and poultry rearing are regarded as important constituents of mixed farming systems as they are economically viable under conditions of limited land resources. Further they concluded that mixed farming yields promising prospects for income and employment generation among farmers who are poorly endowed with natural resources.

Libunao (1990) found that the integration of aquaculture with livestock production offers increased efficiency in resource utilisation, reduces risk by diversifying crops and livestock and there by provides additional food and income.

Baksh and Rahman (1992) examined the existing poultry production and utilization systems at Jamalpur farming systems research site and found that 63 per cent practiced solely chicken farming while 37 per cent practiced mixed farming with chicken,ducks and pigeons and also reported that small farmers were found to benefit more from rearing chickens and pigeons than ducks as these yielded higher incomes.

Singh *et al.* (1993) analysed the economics of different farming systems followed on small and marginal land holdings in Haryana and the results indicated that under irrigated conditions mixed farming with cross bred cows yielded the highest net profit (Rs.20581) followed by mixed farming with buffaloes (Rs.6218) and arable farming (Rs.4615).

Wang and Han (1993) reported that a higher level of efficiency in agriculture can be obtained by combining arable agriculture with animal production than by either alone.

Wimalasuriya *et al.* (1993) suggested that it is possible to improve soil fertility and farm incomes through integration of ruminants into rainfed upland farming systems. A detailed farming systems survey to determine ways and means of developing a sustainable farming system based on crop/livestock integration revealed that 40 per cent of farmers used crop residues to feed ruminants. Manure from livestock was used to fertilize crops by 17 per cent of cattle farmers and 7 per cent of buffalo farmers. Even with this low level of integration in the dry zone, farmers raising ruminants earned an average 88 per cent more income than farmers with no livestock. The findings indicated that crop/ruminants integration could enhance the sustainability of rainfed upland farming in the dry zone of SriLanka, with minimal disturbance to the existing socio economic environment.

Bhende and Venkataram (1994) reported that diversification of farming into livestock rearing provided an opportunity to augment farm income and to reduce income risk, particularly in dry land areas where income from crop husbandry is unstable.

Choudhary (1995) studied the income and employment opportunities under dairy and crop enterprise and found that large herd dairy generate better economic returns in farming situations of agriculture due to minimum cost of milk production, using surplus farm family human labour and by-product. The results also suggested that such mixed enterprise offer a promising scope for development of marginal and small holds.

Enterprise mix is the judicious employment of the various crops that are raised in the farm, adjusting their scale of cultivation such that the products and by-products of one crop complements the production of other crop. Dairy enterprise can also be employed effectively in the farm,making best use of the crop by-products for livestock and cattle manure as farm yard manure.

Various other enterprises like poultry, sheep and goat rearing could also be considered. But as the dairy component contributes a major share in the income of the farms,the various crops raised along with the maintenance of milch animals form the enterprises for this study.

4.Resource Productivity

Allan (1956) measured productivity as the efficiency with which the inputs were transformed into outputs.

Kohls (1956) defined efficiency as a ratio of ends to resources. The ends are to be considered either in the broadest or in the narrowest sense depending upon the particular problem at hand.

Aigner and Chu (1968) developed a stochastic frontier model, by decomposing the error into two parts a stochastic disturbance, one sided efficiency disturbance and then set a joint distribution function based on the error term. Parameters of the stochastic frontier is estimated by the method of Maximum Likelihood Estimate (MLE) or Corrected Ordinary Least Squares (COLS), if the probability function for symmetric and one sided component of the error term are specified. The COLS estimates are easier to compute than MLE, although, they are asymptotically less efficient.

Jacob *et al.* (1971) worked out the relationship between milk yield with different factors of cost and dairy stall size. Feed cost, value of paid and unpaid labour, depreciation on animals, assets and equipments and average number of milch animals in a stall were all taken into account to explain the variation in milk yield. Linear, Quadratic, semi-logarithmic and exponential forms were fitted. As compared to quadratic and semi-logarithmic forms, linear and exponential equations were found to be more appropriate. From the analysis, it was found that feed was consistently observed to be the most significant factor influencing milk yield.

Forsund and Hijalmarsson (1979) relaxed the assumption of homogeneous Cobb-Douglas specification. The advantage of estimating frontier production function is that given a firm with specific technology a firm with specific environment can be specified rather than having a unique isoquant or isorevenue frontier as is defined a linear programming solution. The approach is non-statistical because no explicit statistical model of the relationship between observed output and the frontier is specified other than the fact that observation can not lie below the frontier. Therefore, nothing can be inferred about the statistical properties of the parameters.

Ramasamy *et al.* (1981) fitted production functions for cross bred and non descript cows separately. After examining the relationship between output and each input by scatter diagram, Cobb- Douglas type of production function was chosen. Total digestible nutrient (TDN) supplied by roughages and concentrates, labour employed in man days, value of the animal and management index were taken as variables to explain the variation in milk yield, of which TDN supplied by concentrate, value of animals in rupees and management index were found to be significant for cross breds and non descript.

Sharma *et al.* (1986) opined that resources influencing returns from milk were concentrates is summer, dry and green fodder in rainy season and concentrates and green fodder in winter, green fodder being over utilised in rainy season. The increased use of concentrates in summer and winter and dry fodder in rainy season could improve resource use efficiency.

Sharma and Rajpali (1989) stated that dry fodder, green fodder and labour were under utilised in urban dairy units where as green fodder, concentrates and labour were under utilised in semi urban dairy units in Gwalior and recommended reallocation of existing resources to optimise their utilisation.

Thompson (1988) analysed the relative technical efficiency of individual farrow-to-finish pig production units together with the relationship between firm technical efficiency and selected pig production practices. Data from 18 US states and 555 farrow-to-finish pig farms were obtained from a cross-sectional cost of production study conducted by the Economics Research Service of the US Department of Agriculture in 1981. Two frontier approaches were used, and the resulting estimates were used as dependent variables in explanatory regression models relating technical efficiency among firms to specified production characteristics. Linear programming measures of technical efficiency permitted the derivation of estimates of scale efficiency and congestion efficiency for each pig unit. Scale and congestion inefficiency was shown to be minor compared to technical inefficiency among pig units in each regional sample. The statistical, stochastic frontier approach gave results showing that technical efficiency was higher for larger size pig units.

Yoon and Park (1988) measured the technical efficiency of milk production. For which data were taken from milk production records collected during the 1986 production year from the 80 farms which took part in the Seoul Quantity Quality Milk programme of Seoul Milk Cooperatives. The study employed the stochastic frontier production function approach and the results suggested that there remained much room for increasing the production levels of less efficient dairy farms. It was noted that farms with more than 15 cows showed the highest technical efficiency.

Ureta and Rieger (1990) estimated technical efficiency (TE) using four alternative production frontier models and evaluated the sensitivity of the results to the choice of methodology. The Cobb- Douglas functional form along with data for 1982 and 1983 from 404 dairy farms located throughout six north eastern states in the U.S.A. were used in the estimation. A general conclusion was that, frontier function models are neutrally upwardly scaled versions of the ordinary least squares or average model. A second conclusion was that different models yield markedly different efficiency levels across firms. However, the correlation between the indices from the various method was high, which implied that the ordinal ranking of firms awarding to their measured level of technical efficiency appears to be independent of the method used for a given year. By comparison, the correlation between efficiency indices for the same method across time, although positive, was much lower than the previous set of correlation. Correlation analysis of efficiency versus farm size and of efficiency versus returns over variable costs, based on the alternative models, yielded consistent results.

Rosenberg and Cowen (1990) formulated a model with organisation and personnel management as determinants of dairy operational results with relation to milk output and herd reproduction efficiency and suggested that greater attention to organisation and personnel management could improve results of dairies as well as other agricultural business.

Umesh and Bisaliah (1991) defined economic efficiency as being made up of two components namely production (technical) and allocative (price efficiency). Production is said to be more technically efficient than the other, if it consistently produces larger quantities of output from the same quantities of measurable input or produces ı given quantity of output with lesser quantities measurable inputs. Allocative (price) ›fficiency is said to be price efficiency if it maximizes profit since profit maximization mplies equalization of the value of the marginal product of each variable input to ›rice or opportunity cost.

Ito (1992) took the internal rate of return (IRR) at constant prices and highlights its determinants. A stochastic frontier cost function approach was applied to verify the hypothesis that scale economics and economic efficiency caused dispersive estimation of IRR among sample observations. The approach was applied to dairy and cattle fattening farms in Hokkaido, Japan. The IRR for dairy farms was positively correlated to both expansion of operational size and the improvement of economic efficiency. The IRR for cattle fattening was also positively correlated to improve economic efficiency, but because scale economics did not exist for these farms, an expansion of operational size could not always increase IRR.

Ramamurthy and Naidu (1992) identified feed and fodder as an important factor for increasing the efficiency of milk production and suggested curtailment of labour, veterinary aid and equipment due to their decreased effect on the production of milk. Marginal value productivity of labour was negative for descript and combined farmers. Profit could be achieved by using more quantity of dry fodder and concentrates by all farmers.

Piesse *et al.* (1993) used farm-level panel data to compare the productive efficiency of four cooperative and twelve private dairy farms in the Yugoslav Republic of Solvenia, over the period 1974-90. The data suggested that although some choice regarding the economic organization of enterprises was allowed in Yugoslavia, the restrictions on private farming have led to a dual economy, in which there was mixed evidence of superiority on the basis of ownership structure. This was established by first using Data Envelopment Analysis (DEA) to determine the efficiency frontier, independently of prices. The DEA is complemented by panel data estimation of a Cobb- Douglas production function. Then, the econometric results were used in the construction of a Total Factor Productivity (TFP) index, which showed that productivity growth has been faster in the private sector. Thus, policy needs to be carefully formulated; efficiency is not determined simply by public or private ownership and control and also argued that agricultural dualism is not specific to the ex-socialist countries, but is also typical of much of the third world, where the analysis of efficiency is even more problematic.

Rajendran and Prabaharan (1993) analysed the resource use efficiency of milch animals and expressed resource use efficiency as a ratio of the marginal value product to the difference of marginal factor cost and unity. In case of buffalo and cross bred cow the inputs viz., green fodder and dry fodder were utilised efficiently where as, the inputs viz., concentrates and labour were not utilised efficiently. In case of desi cow all the inputs were used efficiently.

Sampedro and Pinilla (1993) estimated technical efficiency of dairy farms. Panel data were used to look at 112 Spanish dairy farms and to compare the results of a fixed assets model and the estimation of a stochastic production frontier function. The management input was assumed to be similar. The empirical model included data for production area, labour, cows, feed forage (purchase and sale) and equipment. The estimates showed that the efficiency index for use of fixed assets was lower than the efficiency index calculated from the stochastic production frontier. Both indices gave a similar ranking of farms by level of efficiency. The research indicated that some farms were not producing at their optimum. The interpretation of Farrell's index suggested these could reduce production costs by improving management. However fall in significance of factors may indicate that production factors were highly heterogeneous.

Sharma and Singh (1993) analysed the resource productivity and allocation efficiency in milk production and found that the concentrate was the most important input affecting milk production. The regression coefficients of this input were positive and statistically significant in all the equations fitted, indicating that the farmers can increase their milk output by feeding more concentrates to the animals on both the groups of households. The regression coefficients of green fodder and dry fodder were also positive and significant in most of the equations fitted. The coefficient of stage of lactation was significantly negative for all the breeds of animals. The analysis indicated that milk yield was higher in the winter season than in the summer and rainy seasons. The optimisation of resources with the existing capital indicated the possibility of increasing the milk output in cross bred cows and buffaloes by diverting a part of funds from green fodder, dry fodder and labour to concentrates. The final analysis suggested a significant scope for raising milk production by re-adjustment of feed inputs in all the seasons on both the beneficiary and non-beneficiary households.

Devlin *et al.* (1994) used a Cobb-Douglas frontier model to estimate technical efficiency in the Newzealand dairy industry. Relative to research on Australian dairy farms, New Zealand dairy farms appeared to be characterized by a narrower range of production performance and a higher average level of technical efficiency, i.e. New Zealand dairy farmers operated closer to their production frontier. The relationship between farm size and production indicated that, despite the industry trend towards larger farms, there was no evidence that large farms were technically more efficient than small or medium farms. Further more, the finding that the dairy farm sector was characterized by constant returns to scale implies that farm size per se confers neither significant advantages nor disadvantages in the production of dairy outputs.

Perez *et al.* (1994) analysed the technical efficiency of the meat industry in Aragon and the results showed that the meat industry is the branch with the greatest potential influence in the agrifood system of the region. The paper goes on to analyse production and technical efficiency in the Aragon meat industry. A deterministic Cobb-Douglas frontier was estimated using Corrected Ordinary Least Squares regression.

Schilder and Ureta (1994) analysed 84 dairy farms in the central region of Argentina which revealed a significant association between average costs of production and some measures of size and management. The existence of economics of size was verified through the estimation of a per unit cost model. In addition, based on a per unit stochastic frontier cost function, an average cost efficiency index equal to 83.100 pesetas was found. Despite a lower productivity per cow and per worker equivalent, average costs of production in Argentina were found to be lower than those in the U.S.A., Canada and Spain. This cost advantage, however, was not reflected in the net returns experienced by Argentinean producers because the prices they received were much lower than those received by producers in the other countries analysed.

Review of Analytic Techniques

Seitz (1970) presented a method for estimating the frontier production function allowing economics and diseconomies of scale using linear programming techniques.

He offered three equivalent efficiency indices which measured the efficiency of alternative scale activities. He also discussed the utility of efficiency indices in determining the nature of the production function, causes for the observed inefficiency and the degree and nature of technological advance.

The application of the stochastic frontier model to farm-level agricultural data was presented by Battese and Corra (1977). Data from the 1973-74 Australian grazing industry survey were used to estimate deterministic Cobb-Douglas production frontiers for the three states included in the Pastoral Zone of Eastern Australia. The variance of the farm effects was found to be a highly significant proportion of the total variability of the logarithm of the value of sheep production in all states. The ' r' parameter estimates exceeded 0.95 in all cases. Hence the stochastic frontier production functions were significantly different from their corresponding deterministic frontiers. Technical efficiency of farms in the regions was not addressed by Battese and Corra.

Russell and Young (1983) estimated a deterministic Cobb-Douglas frontier using corrected ordinary least squares regression with a cross-section of 56 farms in North-West region of England during 1977- 78. The dependent variable was total revenue obtained from the crop, livestock and miscellaneous activities of the farms involved. Technical efficiencies for the individual farms were obtained using both the Timmer and Kopp measures. These two measures of technical efficiency gave approximately the same values and the same rankings for the 56 farms involved. The Timmer technical efficiencies ranged from 0.42 to 1.00 with an average of 0.73 and sample standard deviation 0.11. But they did not make any strong conclusions as to the policy implication of these results.

Ureta (1986) estimated the technical efficiencies of dairy farms in the New England region of the United States using a deterministic Cobb-Douglas frontier production function. The parameters of the production frontier were estimated by linear programming methods involving the probabilistic frontier approach. Using the 96 per cent probabilistic frontier estimates, Ureta obtained technical efficiencies which ranged from 0.58 to 1.00 with an average of 0.82 and he concluded that technical efficiency of individual farms was statistically independent of size of the dairy farm operation, as measured by the number of cows.

Battese *et al.* (1989) estimated a stochastic frontier production function for farms in an Indian village for which data were available for ten years. Although the stochastic frontier was significantly different from the corresponding deterministic frontier, the hypothesis that the non-negative farm effects has half normal distribution was not rejected.

Kumbhakar *et al.* (1989) used a system approach to estimate technical, allocative and scale inefficiencies for Utah dairy farmers. The stochastic frontier production function which was specified, included both endogenous and exogenous variables. The endogenous variables included were labour (including family and hired labour) and capital (the opportunity cost of capital expenses on the farm), where as the exogenous variables included level of formal education, off- farm income and measures of farm size for the farmers involved. Both types of explanatory variables were found to have significant effects on the variation of farm production. Technical efficiency of farms was found to be positively related to farm size.

Ureta and Rieger (1990) estimated both deterministic and stochastic frontier production functions for a large sample of dairy farms in the north eastern states of U.S.A. for the years 1982 and 1983. The Cobb- Douglas functional form was assumed to be appropriate. The parameters of the deterministic frontiers were estimated by linear programming, corrected ordinary least squares regression and maximum likelihood methods (assuming that the non-negative farm effects has gamma distribution). The stochastic frontier model was estimated by maximum likelihood techniques (given that the farm effects has half normal distribution). The stochastic frontier model has significant farm effects for 1982 but it was apparently not significantly different from the deterministic frontier in 1983. The estimated technical efficiencies of farms obtained from the three different methods used for the deterministic model showed considerable variability but were generally less than those obtained by use of the stochastic frontier model. However, they found that the technical efficiency obtained by the different methods were highly correlated and gave similar ordinal rankings of the farms.

For the present study, production function is referred to as the relationship between the milk yield in litre per milch animal per lactation and the inputs viz., green fodder (in Rs.) per milch animal per lactation, dry fodder (in Rs.) per milch animal per lactation, concentrate (in Rs.) per milch animal per lactation, labour (in Rs.) per milch animal per lactation, cost on health care (in Rs.) per milch animal per lactation, herd size (in numbers) and dummy variables (0 for buffalo and 1 for cross bred cow). Stochastic frontier production function is applied in the present study to measure the technical efficiency of dairy farms for different category of farmers.

5. Programming

Programming, more popularly known as linear programming, is a refined mathematical tool of analysis. In linear programming, the quantity to be maximised or minimised is stated as a linear function of independent variable and is subjected to linear inequalities stated in terms of these variables. It is an empirical tool or mathematical technique of activity analysis.

Heady (1954) stated that because of its 'apparent complexity' linear programming was not widely used. He pointed out that linear programming has the advantage for large scale problems and it could specify the optimum programme in a fraction of time required for the more cumbersome budgeting. Linear programming could also "dip deeper" into problems. He explained the logic of linear programming with a simple two crop example of profit maximization.

Swanson (1956) arrived optimum crop and livestock plan using linear programming. The constraints were capital available for each expenses, capital requirement, the pasture days available and labour restrictions for three peak periods.

Lancaster (1968) stated that programming could be used to derive optimum plans in a farming situation which satisfy all the resource constraints at farm level and yield maximum value of the objective function. Optimisation is a 'catch all' term for maximising or minimising or finding a saddle point and is the heart of any economic analysis.

Pandey and Bhogal (1980) employed linear programming to derive the optimal crop and milk production plans for various groups. Results showed that medium size mixed farms enjoyed comparative advantage over the small and large farms taking into consideration the availability of fodder and human labour. Farm income and employment could be increased substantially on all the size groups of farms through the adoption of optimal crop and milk production plans with improved production process.

Sirohi *et al.* (1980) attempted to optimise the use of farm resources for production of crops, dairy and poultry products for maximising farm income. Poultry enterprise resource optimisation and credit facilities increase the farm income to two and a half times and the employment of labour in marginal, small and medium farms consequently had to have the labour for several months.

Pandey *et al.* (1982) used variable price programming technique for the analysis of dairy enterprise vis-a-vis crop cultivation and indicated that Rs.2 is the minimum price of buffalo milk essential to incorporate the dairy activity in the farmer's production plan on competitive basis. The returns from dairy enterprise increased with the increase in buffalo milk price. The returns from fixed farm resources also increased under different optimum plans over the existing income. As a result the demand for credit, hired labour and other dairy inputs increased indicating the employment of human labour with the commercialisation of dairy enterprise along with the crop enterprises.

Patel and Gangwar (1983) analysed the potential for farm income and employment in dry farming areas of Haryana using linear programming. The findings showed that by making the required capital available to the farmers, profit in all sizes of farms could be increased considerably and the improved technology generated more income and employment of labour.

Sivanantham (1983) employed linear programming for optimising crop mix that would maximise the net return by allocating the resources optimally. In this study, in addition to rainfall and ground water, storage and inflows to the reservoir were estimated and specified as the water resource potential available for optimum allocation of the reservoir water.

Sardana and Panghal (1984) used linear programming technique as analytical tool in increasing the income and employment on small farms through dairying. The analysis revealed that the reallocation of existing resources, even at the existing technology would increase the income and employment on small farms. But with improved technology along with relaxed capital constraint, the income and employment can considerably be increased. Thus, introduction of livestock enterprise and improved technology along with adequate capital resources would increase the income and employment of small farmers significantly.

Satheesh *et al.* (1985) developed optimal plans for four farming systems, viz., crop, crop + dairy, crop + sericulture and crop + dairy + sericulture at two levels of technology with and without borrowed capital. The constraints included were land, labour (human and bullocks), capital, maximum number of dairy animals and minimum cereal. The study was undertaken in non-viable farms.

Thorve and Galgalikar (1985) worked out the economics of diversification of farming with dairy enterprise. The study focused on the impact of dairy enterprise on the costs and returns of different size groups of farms, the feasibility of different levels of milch cattle on different size groups and the optimum number of milch cattle using linear programming model.

Prabaharan (1986) attempted to arrive at a least cost combination of feed mix to dairy cows, with constrained optimisation by linear programming .The two minimum constraints were total digestible nutrient and digestible crude protein.

Kirke and Moss (1987) used linear programming to examine the probable responses of small and medium sized dairy farms to various policies in Northern Ireland. The results indicated that there were considerable potential for expansion of production in the dairy farming sector.

Possibility of increasing the income and employment farming systems on small farms in midwestern region of Uttar Pradesh were examined by Singh and Sharma (1988) using linear programming. The crop + dairy + poultry farming system had maximum potentialities of income and even in optimised farming system, dairy enterprise had appeared as a major source of income.

Steinfeld (1988) concluded that livestock is essential for cropping to provide work and manure while their outputs such as milk and meat contribute to household consumption and income. At the same time livestock also constitutes as a significant asset in terms of security and wealth.

Bhogal *et al.* (1989) formulated optimum crop and milk production plans for small and marginal farmers. The results showed that there existed the possibilities of reallocation of resources among various milk production and crop activities on small and marginal farmers and it was found that milk production was relatively more important for marginal farmers from the point of view of its existing and potential contribution to the family income than that for small farmers.

Kombairaju (1989) applied deterministic linear programming model to develop optimum crop plans to minimise the total variable cost of crop production and to maximise the net income. Land constraints were considered separately for irrigated and rainfed crops. Men labour, women labour, bullocks labour, fodder, income, nutrient and electricity were considered as constraints.

Gajanana and Sharma (1990) employed profit maximising linear programming technique to explore the possibilities of increasing the income and employment through adoption of liberal credit policy and recommended technology. On optimisation of resource allocation, both returns and employment prospects improved substantially in dry farming areas. Liberal credit policy and recommended technology further enhanced the prospects of income and employment.

Sharma and Mehta (1990) studied the combination of milch cattle (including buffaloes) and crops required to reach such an optimum and analysed its effects on farmers' income. A two-stage stratified random sampling method was used to classify farms into small, medium and large size. A linear programming model was followed and used two 'plans' of resource utilization. Plan A involves the use of existing resources with existing technology and plan B uses existing resources and modern crop and dairy cattle technology such as cross breeding. Each plan was studied under two situations to identify the effect of fodder availability. Results showed that the percentage increase in income on small irrigated farms was greater in cases where modern crop and dairy technology were used. This impact was somewhat lower on large irrigated farms. The replacement of local cattle with cross bred cows also led to a considerable increase in the milk supply and better nutrition levels. Other benefits included employment generation, reduced pressure on land and the release of scarce resources.

Deoghare *et al.* (1991) developed optimum plans to existing technology level and modern technology with restricted and unrestricted capital. The result showed that reorganisation of resources at recommended levels of technology was quite instrumental in raising the farm returns when capital constraint was relaxed.

Sankhayan and Cheema (1991) analysed the use of linear programming in farm plans and gave standard formats. The study revealed that the use of linear programming model for farm planning was correct and simple alternate formulation of linear programming for farm planning was developed directly incorporating cost of purchased inputs as coefficients of the respective resource.

Chaudhry and Chaudhry (1992) investigated the possibilities of increasing net farm income by including labour intensive dairy enterprises and vegetables along with crops under existing levels of technology in Pakistan. Linear programming was used to determine the optimum allocation of resources and combination of activities on farms. Results were obtained on the optimum and feasible number of buffaloes, optimum cropping, milk and milk products, that helped to secure net cash returns which could not be achieved through crops alone; provided employment for some of a family's excess labour. It served as a useful outlet for crop by- products which would otherwise go to waste. It was concluded that increased net cash returns could be achieved by mixed farming even with subsistence food restrictions, through efficient resource allocation and improved marketing practices.

Raman and Jain (1992) analysed the potential of introducing dairying enterprises to various farm situations with a view to supplement farm income and generating more employment opportunities. The study involved 25 each of small, medium and large farms in Jalandhar district (Punjab, India) and 2 plans were prepared, with a profit maximization technique of linear programming, plan I for optimal mix of crops while maintaining dairying at the existing level and plan II incorporating both dairying and crop enterprises. By introducing plan II on small, medium and large farms respectively the following changes are predicated; an increase in the number of milch animals/farm to 3, 4 and 5 buffaloes, 1, 2 and 4 crossbred cows, and 1, 1 and 1 local cows; an increase in total labour (man-h) of 27.17, 6.17 and 11.33 per cent; an increase of 47.78, 50.37 and 76.05 per cent in buffalo milk production, but a decrease in its share of total milk production due to the considerable increase in numbers of high- yielding cows; an increase of 80.24, 121.15 and 163.89 per cent in total milk production; an increase of 61.03, 21.85 and 23.46 per cent in gross returns; and an increase in returns to fixed farm sources of 64.54, 28.43 and 32.19 per cent.

Patil *et al.* (1993) designed new farming systems with crop and dairy, for conditions representative of the rain-fed farming around Baroda in Gujarat, India. Linear programming was used to optimize the number, type and production level of cows that could be maintained on feed from different cropping level of cows that could be maintained on feed from different cropping patterns. The usefulness of feeding dairy cows on urea-treated straw was also tested, in 2 model farming systems. The use of urea-treated straw or stover or supplementary concentrates resulted in increased milk production, especially among highly productive cows. The conclusion was that the mixed farming system is more rewarding than the system of cash crops only, provided that the animal productivity should be adjusted to the feed quality, so as to be able to utilize the available feed biomass.

Jalvingh *et al.* (1994) used linear programming to determine optimal farm-specific herd calving patterns. The required technical and economic parameters were calculated with a dynamic probabilistic simulation model of the diary herd. The method was illustrated with a situation in which the object was to maximize the gross margin of the herd when the annual milk yield of the herd was restricted. For such a case, the optimal calving pattern was one in which all heifers calved during August When only home-reared replacements were allowed to enter the herd and heifer calvings were in July - October the gross margin was reduced by Dfl 13 per 100 kg. of milk. The sensitivity of the optimal calving pattern was examined for different rates of reproduction and ignoring seasonal price variation.

Sethi and Nagarcenkar (1994) developed a system model for optimizing buffalo production under a wide range of conditions with animals differing in genetic potential for body weight, milk yield, service period and dry period. In the model, genetic potential is specified as a function of the standard normal deviation from least- squares constants. Feed intake was estimated from nutritional equations as a function of growth, maintenance, reproduction and production in terms of the crude protein, total digestible nutrients and dry matter contents of the feed. Least-cost rations estimated using linear programming were used to estimate multiple regression coefficients for predicting the cost of feeding. Data on body weight, milk yield, fat yield, death and replacement rates, sale price and purchase cost and production and reproduction variables are estimated by the use of least-squares constants, regression equations and life tables. The model was used for simulating buffalo productivity for different female calf rearing policies at location with different socio-economic conditions in India.

Thomson *et al.* (1995) found that a model farm with integrated crop- sheep enterprises had twice the output of metabolizable energy and a higher stocking rate compared with a model farm with traditional rotations. A linear programming model suggested that integration improved farm profits and stocking rates, but improving the nutritional regime of ewes reduced farm profits. The model-farm approach allowed close supervision of animals but otherwise has several weaknesses, in particular the difficulty of mimicking the normal farm environment. If the weaknesses are corrected, the approach could be applied with substantial benefits in national programmes that have under-utilised land, animal and staffing resources.

Review of Analytic Techniques

Initially, Desai (1962) attempted to use the linear programming technique to determine surplus labour in the farming situation, the marginal value products of capital required for cash expenditure and the most competitive crop activities of the region. He illustrated both the budgeting and programming techniques and demonstrated the advantage and case of using programming over that of budgeting.

Dhawan and Johl (1967) explored the economic potentialities of dairy animals in increasing farm income by rationalising the resource use. They found out the opportunity cost in terms of percentage of income scarified for different degrees of certainty and regularity in income provided to two different levels of dairy enterprise, if dairy does not figure in the optimum plan. They found that introduction of dairy at a moderate level improved resource use, by more employment throughout the year with no adverse effect on land-use efficiency.

According to Barnard and Nix (1973), linear programming technique is an appropriate tool for assessing the performance of the farming systems, including on a micro-farm level. Linear programme can be used to assess the contribution of each enterprise to the total farm income and it is particularly suitable for farm level resource allocation decisions for maximising profits. The technique is also suitable for evaluating technologies as it takes into account some farmer circumstances like prices and resources. The tool allows interaction between production parameters and quantities, the impact of limiting factors by shadow prices and can also be used for simulation.

The application of linear programming as a tool for planning purposes gained prominence in the 1940s when the technique was being used for planning transportation problems. The objective function in an linear programming model may be least cost combination of limited resources of maximisation of net income and or employment. In agricultural production processes one can simulate through the model for various technologies according to Sharma and Sharma (1981).

Eicher and Baker (1982) have classified major uses of linear programming in African small-scale farming as:

i) for identifying constraints taking small farm households in the farming systems

ii) developing functions for normative supply and input demand

iii) estimating frontier production functions based on cross-sectional data

iv) for evaluating the profitability of new technology.

v) for the development of management strategies and evaluation of those strategies.

Sharma and Moorti (1991) developed risk efficient farm plans using MOTAD model. The risk efficient plans showed that unit of cross bred cows and poultry would increase with the increase in gross margin. They evaluated different levels of risk and income associated with them. The farmers have an option to choose from the different plans suggested by the model as per their risk criteria.

Bhowmick *et al.* (1992) identified the different types of farming systems in Sonitpur district, Assam and optimised the resource use among different size groups of farms using deterministic linear programming technique. The net return increased from Rs. 11,516 to Rs. 18,480, Rs. 17,180 to Rs. 23,900 and Rs.24,805 to Rs.40,806 in small, medium and large farms respectively in the optimum farming system (crop + dairy + goat + pigeon and duckery).

For the present study linear programming model was used to develop optimum plan for efficient utilisation of available resources. The objective function of the model was to maximise net income at farm level treating land, labour, green fodder, dry fodder, concentrate and cost on health care as constraints. Sensitivity analysis also undertaken to capture the effect of possible fluctuations in resource availability, programming was run with changed resource level, for the green fodder and concentrate.

None of the analytic techniques mentioned above was without limitations. Cost benefit analysis has been very useful when the choice was between multiple alternatives. However, frequently confusion prevailed, even among economists due to lack of under standing of financial profitability of dairy farm to the individual and its economic profitability to the society.

Multiple regression analysis and analysis of variance of cross section data are very useful if adequate data are available. However the results might be of limited use to policy makers as a result of lack of data and of the bias resulting from the omission of relevant variables.

Linear programming was the best tool available for deciding the optimum levels of resource use on individual farms. However, the main problem was that the farmers maintained the profit subject to certain constraints.

While each one of the analytic techniques mentioned above had its scope and limitations they had been used rather extensively in research pertaining to farm production. As stated above, the choice of the technique was mostly disputed by the nature and reliability of the data. Thus the choice of the model was problem specific, the model found appropriate for the objectives of the present study is discussed in the next chapter.

6. Constraints

Kumar and Raut (1971) analysed the factors influencing the economy of milk production and reported that a reduction in feed cost can be attained by reducing the lactation length as well as dry period without affecting the lactation yield. The cost on feed could be reduced by one paise per kg. of milk if the milk yield per lactation would be increased by about 8.5 kg. without affecting the inter- calving period. A reduction of one paise per kg. of milk can be attained by decreasing the lactation length 6 days without affecting lactation yield and dry period.

Singh and Jha (1975) worked out the economic optima in milk production and found that farmers cared more for the Murrah than non-descript and also reported that in the rainy and summer seasons, significant increase in the milk yield could be obtained by reallocation of feed inputs.

Srivastava and Promila (1985) suggested that amongst the different areas of dairy management, feeding is one important area directly related with the increase of milk yield leading to increase in farm income. Recommended feeding practices were adopted to a great extent, yet, a majority did not feed the recommended amount of concentrate to the pregnant buffaloes during pregnancy; balanced concentrate ration and mineral mixture to the milch buffaloes.

Chauhan*et al.* (1988) in their study on economic constraints for sheep development in a tribal area of Himachal Pradesh found that the fodder scarcity was the foremost problem for the development of sheep followed by absence of marketing facilities for wool and livestock.

Mahipal and Kherde (1988) conducted a study on adoption of scientific dairy farming practices by landless cattle keepers and found that the extent of practice was the highest incase of management practices and the lowest in case of health care practices. This implied that the respondents adopted the less costly and simple practices than the costly and technically complicated practices. The respondents perceived overall constraints to the extent of 48.68 per cent in the adoption of scientific dairy farming practices. Economic constraint perceived to the extent of 74.80 per cent was the major constraints followed by socio-psychological, technical and organisational/administrative constraints. A positive and significant correlation was observed between the variables such as socio-economic status, herd size, level of aspiration, mass media and informal sources utilisation and the overall adoption of dairy innovations.

Singh and Jain (1988) employed constraint analysis for identifying the biophysical and socio economic constraints impeding higher milk production in the hilly area of Himachal Pradesh. The results of the analysis revealed that the feed intake interms of digestible crude proteins and digestible non-nitrogenous nutrients and housing conditions were the most important biophysical factors influencing milk production. Among the socio economic constraints high prices of feed, low conception rates, lack of adequate credit and veterinary facilities were found as the main reasons for not adopting improved technology.

Tambi (1991) suggested that a coordinated development strategy is believed to be required for the dairy industry to remove constraints on rural producers, ensure remunerative prices for products and promote cooperatives, to integrate milk production, processing and marketing into rural development.

Phelan (1992) concluded that the technical constraints and policy considerations were directly influenced the course of dairy development in developing countries.

Thirunavukkarasu *et al.* (1992) used Garett's scoring technique to rank the constraints faced by the beneficiaries of Operation Flood and found that very low procurement price for milk was a major constraint which denied them easily attainable benefits. The second to seventh constraints were in the order of pricing of milk on fat content, poor quality of the feed supplied by State Federation, rate of conception, higher mortality in crossbred cows, inadequate financial assistance for buying milch animals and inadequate veterinary services.

Kidane (1993) examined the major economic problems related to milk production in Kenya. The results suggested that land and operating capital as the major limiting factors of production. Sensitivity analysis was used to determine the ability of the optimal solution by varying the values of the limiting resources. Accordingly, Changes in the land area and value of working capital have significant effects on milk production. It was concluded that farmers should be given incentives such as credit facilities to enable them to purchase additional farm inputs. Thus milk production will be intensified by keeping graded cows and improving the methods of feeding. With intensification labour and capital will be effectively utilised.

Rajendran and Prabaharan (1993) conducted a study to know the factors affecting the choice of milch animals and problems in the management of milch animals and found the following as the most important problems encountered in the management of the animals (in descending order of maintenance for each group) : breeding problems, low milk yield, high feed requirement and costly veterinary treatment in buffaloes, breeding problems, high investment costs, frequent illness, high feed requirement, high treatment costs and low milk yield in cross bred cows and low milk yield, breeding problems, high treatment costs, frequent illness and high feed requirement in desi cows.

Prabaharan and Thirunavukkarasu (1994) analysed the constraints in goat farming and the analysis of data revealed that inadequate fodder and grazing lands, social ban on grazing of goats and problems in marketing of goats viz. unscientific pricing and exploitation by middlemen were the major constraints identified by the farmers limiting the prospects of goat farming in Tamil Nadu.

Rezo (1994) analysed, fluctuations in milk production, using a multiplicative model of multiple regression , with analysis based on the logarithmic form of the Cobb-Douglas function and the parameters taken into account included milk consumption, purchase price of milk, numbers of suckling cows and piglets, number of milking cows, milk yield per cow, number of cows being selected for milk production, the volume of feed production and the volume of milk production. It was established that a one per cent increase in milk consumption would, *ceteris paribus*, be associated with a 1.05 per cent increase in milk production, increasing the number of cows being raised for milking by one per cent would, ceteris paribus, cause a 0.12 per cent increase in milk production; and increasing feed production levels by one per cent would, ceteris paribus, cause a 0.43 per cent in the volume of milk production. Changes in the other variables investigated were not associated with statistically significant changes in the level of milk production.

Stojanovic and Katic (1994) discussed the current problems faced by producers of milk and milk products in Serbia under the following headings: the economic motivation of milk production; hygienic quality of milk produced; the organization of milk testing; and problems in production and distribution. It was suggested that one method of motivating farmers to improve milk quality could be introduced a system for milk payments in which milk prices are determined on the basis of results of quality tests.

Sivanarayana and Reddy (1995) found that lack of knowledge, non- availability of cross breds, poor adaptability of cross breds, unaware of the practice, scarcity of own grazing land, poor economic status, negligence of the practice, non-availability of concentrate mixture, difficulty in premium payment and careless/indifferent attitude towards insurance of animals as the major constraints that were found in the adoption of improved sheep and goat practices by the small and marginal farmers of diversified farming.

Yadav *et al.* (1995) conducted a study to find out the constraints in dairy enterprise. The results of the study indicated that the weak financial status, cost factor and management difficulties were the main constraints for not maintaining good quality animals on the farms. The respondent farm families strongly expressed the dire need of finance for the purchase of milch animals and feed and fodder. They opined that good quality feed and fodder should be made available to them at reasonable rates and that they need to be assured reasonable and stable prices for milk throughout the year to make the dairy enterprise as a supplementary and paying proposition.

For the present study, the constraints in milk production were identified as i) high investment, ii) low productivity iii) high cost of feed, iv) low price of milk, v) repeat breeding problem, vi) costly veterinary treatment and aid, vii) frequently become sick, viii) in adequate infrastructures in marketing of milk and ix) inadequate input supply. The respondents were asked to rank the nine constraints listed and the ranks were arrived by using the Garett Scoring technique.

DESIGN OF THE STUDY

CHAPTER III

DESIGN OF THE STUDY

Formulation of a design of study helps to draw systematic approach for any esearch. It ensures choice of method of sampling and methods of analysis appropriate o objectives set for the study. This chapter briefly sketches the selection criteria dopted for the study and the rationale behind its choice, the methodology followed n collection of data, the sampling method and the mathematical and statistical tools nd techniques used for the analysis of the data.

HOICE OF THE AREA

Dharmapuri district of Tamil Nadu was purposively chosen for this study, because he district contributes 7.28 per cent of milk to the total, possesses 6.28 million ovine, relative better viability of milk producer's societies (620 societies) and better doption of modern husbandry practices. Further it is identified as a backward district nd hence many rural development programmes are implemented by both state and entral governments to alleviate the rural poverty. Among the rural development rogrammes, dairy development is one of the important programme of this district.

The study area experienced periodical instability in water table level due to fluctuations n the monsoon. This region greatly benefits from Operation Flood, implying the importance f dairying in the study area. This shows that there is greater opportunity for integration f crop and dairy in the existing farming system of the farmers.

AMPLING PROCEDURE

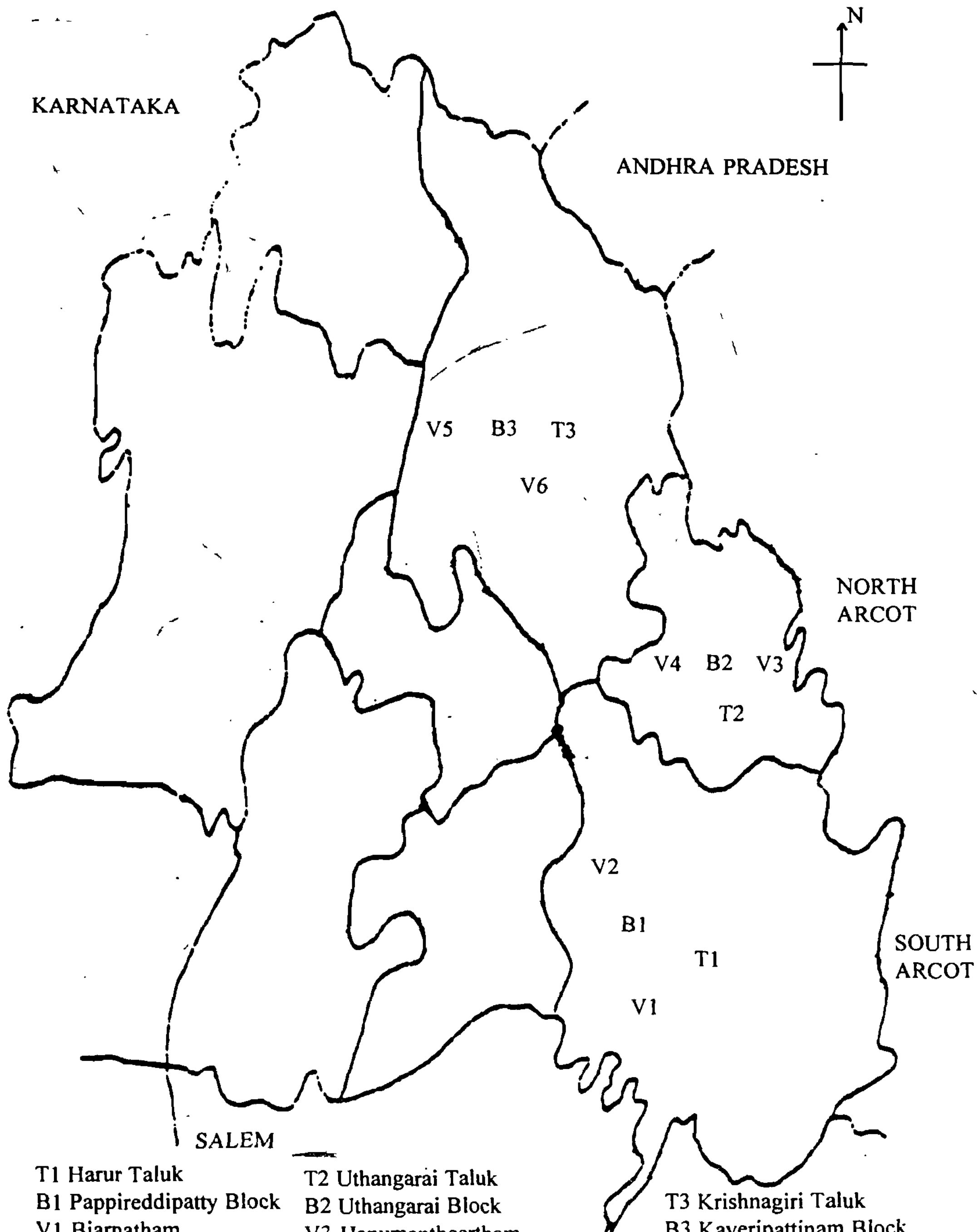
The secondary data available in the district were collected to know the pace and attern of enterprises available in the recent past. However the main focus of the tudy is based on the primary data. For this purpose a multistage random sampling echnique was adopted. In the first stage, three taluks were selected out of the eight aluks in the district based on the largest number of enterprises available viz., lairy, poultry and sericulture. In the second stage one block from each taluk was andomly selected and in the third stage two villages from each block (Pappireddipatty Block - 35 villages, Uthangarai Block - 33 villages and Kaveripattinam Block - i0 villages) were selected randomly. A sample of 360 farmers were selected andomly from 1011 farmers within the selected six villages. The selected taluks, blocks and villages are presented in Table I. The study area map is shown in Fig.1. The selected farmers were post stratified into four categories depending upon heir operational holdings as shown in Table II.

TABLE I
DISTRIBUTION OF SAMPLE FARMERS IN THE STUDY AREA

Taluk	Block	Village	Number of Farmers				
			LL	MF	SF	LF	Total
Harur	Pappireddipatty	i) Baiyarnatham	16	13	20	13	62
		ii) Erumiyampatty	15	18	20	16	69
Uthangarai	Uthangarai	i) Hanumumtheertham	14	10	13	14	51
		ii) Periathalapadi	18	16	18	15	67
Krishnagiri	Kaveripattinam	i) Paiyur	11	17	17	14	59
		ii) Nedungal	15	13	11	13	52
Total			89	87	99	85	360

FIGURE 1

MAP SHOWING LOCATION OF SAMPLE FARMS



T1 Harur Taluk
B1 Pappireddipatty Block
V1 Biarnatham
V2 Erumiampatty

T2 Uthangarai Taluk
B2 Uthangarai Block
V3 Hanumantheertham
V4 Periyathalapadi

T3 Krishnagiri Taluk
B3 Kaveripattinam Block
V5 Paiyur
V6 Nedungal

TABLE II
CLASSIFICATION OF FARMERS BASED ON LANDHOLDINGS

Categories of farmer		Operational holdings (in acres)
Landless labourers	(LL)	–
Marginal farmer	(MF)	upto 2.5
Small farmer	(SF)	2.6 – 5.00
Large farmer	(LF)	5.01 and above

PERIOD OF STUDY

The field survey for this study was conducted during the months of January-March 1996 and the data and information were related to the year 1995-96.

SOURCE AND NATURE OF DATA

Before conducting the field survey a reconnaissance survey was conducted to get an understanding of the agricultural and dairy potentials of the area.The data were collected by personal interview with the help of a pre-tested comprehensive interview schedule. The usefulness of the study was explained to the farmers prior to enquiry to elicit their cooperation. The primary data were collected on socio-economic conditions of the sample farmers like age, education, size of family, number of dependents, cropping pattern, size of operational holdings, existing farming systems etc. Information on cost of cultivation, inputs used, crop yield, price of output,number and value of the milch animals, investment on buildings and equipments, expenditure on feeds and fodders, miscellaneous charges comprising water, electricity charges and insurance charges, labour, income from milk, manure and gunny bags were also gathered and used to develop input-output co-efficient for different activities.

Besides the data collected from the farmers, secondary data on land utilization pattern, area under principal crops, agro-climatic conditions, rainfall, population, workforce, size of holdings, irrigation sources, livestock population etc. for the study area were collected from the records of the state development departments, Directorate of Economics and Statistics and Directorate of Census.

METHODS OF ANALYSIS

The data collected were tabulated and analysed in terms of the objectives of the study. Specific tools appropriate to analyse the data with reference to each of the specific objectives were selected and used.

Measurements

The methods of measuring some of the important variables studied are described below:

Human Labour: It was measured in mandays (8 hrs a day) for the purpose of standardising the work units of different categories of labour. In the present study, two women were equated to one man based on the wage rate prevailing for them. On an average, the daily wage rates were Rs.40, Rs.20 and Rs.15 for men, women and child labour respectively. Family labour and hired labour were treated alike.

Machine Labour: The cost of machine labour was computed at the prevailing hire charges.

Seeds: Seeds and seedlings were valued at actual prices paid and the cost of farm produced seeds was imputed at prevailing market prices.

Manures and Fertilizers and Plant Protection Chemicals: These were valued at actual price paid and farm produced at the prevailing market rates.

Interest on Working Capital: The interest for short term credit, 14 per cent per annum was charged on working capital.

Method of Estimation of Cost

The formulation of the various costs in milk production were presented in the following sections.

Fixed Investment: The cost of buildings, cost of equipments and machinery, investment on water and electricity installations and the cost of animals were grouped under fixed investment.

Cost Components

The cost components have been classified into fixed cost and variable cost.

Fixed Cost: This included interest on fixed capital, depreciation on buildings, depreciation on equipments and machinery and insurance cost.

i) Depreciation on buildings

Depreciation at the rate of 20 per cent for thatched wall as well as thatched roof (Kuccha), 10 per cent for mud walls with thatched roof (semipucca) and 5 per cent for brick walls with RCC roof (Pucca) were calculated.

ii) Depreciation on equipments and machinery

The depreciation was calculated at the rate of 10 per cent for steel items, 15 per cent for plastic equipments and 50 per cent for mud items.

iii) Depreciation on animals

The value of the animals based on milk yield and order of lactation was taken. No depreciation was calculated for animals upto the third lactation and after that they were considered to depreciate in a straight line.

iv) Interest on fixed capital

The interest rate of 15 per cent per annum on the total value of animals, buildings and equipments and machinery were worked out.

v) Insurance

The premium rate of 6 per cent of the value of the animal was considered.

Variable Cost: This included cost of feed (dry fodder, green fodder and concentrate), medicine and veterinary charges, wage paid to permanent, family and hired labour and miscellaneous costs.

i) Feed cost

The cost on dry fodder, green fodder and concentrate were calculated at the prevailing market rate during the survey.

ii) Labour cost

The actual time spent by the labour on the entire herd in a household were ecorded. The payments in kind made to the permanent labourers were converted into monetary terms. The value of hired and permanent labour were recorded as reported by the respondents, while the family labour was valued at the wage rate of hired labour.

iii) Medicine and Veterinary charges

The cost involved in the purchase of medicines, deworming, vaccination and fees paid to veterinary doctors were included under medicine and verterinary charges.

iv) Miscellaneous costs

The miscellaneous charges included the electricity and water charges, repair and maintenance of buildings and equipments and machinery.

Total Cost: It included all the components of fixed and variable cost.

Cost of Milk Production: The gross cost was divided by the total milk yield to arrive at the cost of milk production.

Gross Income: The returns in milk production included the income realised through the sale of milk, manure and gunny bags. The value of milk, manure and gunny bags were valued at the rate prevailing during the period of study.

TOOLS OF ANALYSIS

The various tools used to analyse the data are as follows.

Conventional Analysis

The various cost components of milk and crop production, gross income and expenditure, general characteristics of the sample household and the like were analysed by the conventional analysis in the form of averages and percentages.

Functional Analysis

To evaluate the production efficiency of dairy farms and to analyse the differences if any between different categories of farms with respect to production efficiency, analysis of production function was chosen because it would show the productivity of resources and returns to scale. Productivity per farm was worked out for each village and its homogeneity was tested between the selected two villages in each block using analysis of variance. Since the productivity per farm did not differ significantly between the two villages, it was decided to fit blockwise production function for different categories of farmer. (i.e. Block I : Biarnatham + Erumiyampatty, Block II : Hanumumtheertham + Periathalapadi and Block III: Paiyur + Nedungal) but the blocks exhibited significant variations in the net income. Hence it was decided to perform analysis individually to capture the variations. The text book definition of production function holds that it gives the maximum possible output level which can be produced from quantities of a set of inputs. When the production is estimated using the Ordinary Least Squares method (OLS) and evaluated at the mean level, it would give only average production and not maximum production. To overcome this difficulty the concept of frontier was applied.

The measurement of efficiency has been the motivation for the study of the frontier. The distance by which the actual production point (level) lies below the production frontier (implied by maximum production) is considered as a measure of production inefficiency. The concept of efficiency involved the following three components:

1. technical efficiency is the ratio of actual production (y_{it}) to the maximum possible production $\hat{y}_{it}$. This ratio is positive and is less than unity,

2. allocative efficiency which is obtained by equating the marginal rate of technical substitution (MRTS) or the ratio of the marginal productivities of resources in the frontier production to factor prices, and

3. a combination of technical and allocative efficiencies which is a necessary but not a sufficient condition for production efficiency. It should also be scale efficient.

Since production frontier function is useful to study each of these components in the overall production function, it was employed in the present study. Though numerous alternative mathematical forms could be used for estimating the production functions the Cobb-Douglas production function was chosen for the following reasons. The shape of the production curve depends on the nature of complementarity and substitutability among the factors of production. There are three cases viz., complementary factors of production with fixed proportions, complementary factors of production with variable proportions and full substitutability between factors of production.

In farm production the possibility of inputs being either of type second or third or both. To each of these latter types of production functions can be associated - transcendental and Cobb - Douglas respectively, of which transcendental function incorporated all the three stages of production while Cobb - Douglas explained only the important second stage of production assuming perfect competition.

Frontier Production Function

The maximum feasible yield function is defined as one that corresponded to the best practiced technique among the given producers. The production function showing such maximum feasible yield may be estimated by means of frontier production function. The frontier production function is defined as follows.

$$Y = f(X) \exp(w) \qquad \text{... (1)}$$

where Y = a(n x 1) vector of observed output
X = a(n x k) matrix of inputs
exp(w), the error term

Suppose that a farm's production is observed at a production plan (X^0, Y^0) such a plan is said to be technically efficient if $Y^0 = f(X^0)$ and inefficient if $Y^0 < f(X^0)$. Then maximum feasible yield could be defined as $Y = \max(Y_i : H_i)$, where H_i is the state of technology for the i^{th} farm. This maximum feasible yield is feasible for all but is realised by at least some sample farmers. These farmers were taken to be the reference cases to define maximum production. Then the production function is $Y_i = f_i(X_{ij} : H_i)$, where Y_i is the yield per hectare and X_{ij}, per hectare level of input vector and Y_i gives the actual production of the i^{th} farmer. The difference between the two is a measure of inefficiency in the production which implied that there is still scope for those who have not realised maximum feasible yield to raise production with the given technology by bridging in technology adoption.

Stochastic Frontier Production Function (SFPF)

A major limitation of the frontier production function is its assumption of deterministic relationship which ignores the very real possibility that a farm's performance may be affected by factors entirely outside its control as well as by factors under its control. The former is the collective effect of exogenous shocks both favourable and unfavorable and the latter is due to inefficiency in use of technology. Therefore the two sources of errors need to be separated to understand the real effect of inefficiency. This is the idea behind the stochastic frontier production function.

In stochastic frontier model the error is composed of two parts. A systematic component which permits random variation of the frontier across the farms and comprises effect of statistical noise and random shocks outside the control of the farms. A one-sided component captures and effect of inefficiency relative to the stochastic frontier. The model is as follows:

$$
\begin{aligned}
Y &= f(X)\exp(w) \\
  &= f(X)\exp(-u+v) \qquad \text{... (2)}
\end{aligned}
$$

where the stochastic frontier is f(X) exp(v), v has symmetric distribution to capture the random effect measurement errors and exogenous shocks which causes the placement of the deterministic kernel f(X) to vary across the farms. Technical inefficiency relative to the stochastic production frontier is then captured by one-sided error component exp(-u), $u > 0$. This condition ensures that all the observations lie beneath the stochastic production frontier.

Consider the Cobb-Douglas function defined as

$$Y_i = A \prod_{j=1}^{n} (x_{ij})^{\beta_j} \cdot \exp(w_i) \qquad \text{... (3)}$$

On natural log-transformation it becomes

$$Y_i = \beta_0 + \sum_{j=1}^{n} \beta_j x_{ij} + w_i \qquad \text{... (4)}$$

where lower case letters represent the log values of the corresponding variables in (2) and β_0 = log A. Dividing the disturbance term w_i into two components a stochastic disturbance v_i and one-sided efficiency disturbance u_i and set a joint density function based on the error term could be arrived.

$$w_i = +u_i + v_i \text{ for all } i \qquad \text{... (5)}$$

The model with this error specification is called as stochastic frontier since the non-positive component of the disturbance represents the shortfall of actual output from the frontier while the frontier contains normal component of disturbance and is therefore stochastic. The specification avoids serious statistical difficulties as discussed by Greene that are encountered in the estimation of full frontier i.e., the presence of a purely non-positive error term (Greene, 1980).

Direct estimates of the stochastic production frontier may be obtained either by maximum likelihood estimation procedure (MLE) or by corrected ordinary least squares method (COLS) (Appendix I). Introducing specific probability distribution for u and v and examining that u and v are independent and that X is exogenous, the symmetric properties of MLE's can be proved in the usual way.

Whether the model is estimated by COLS or MLE the distribution of u and v must be specified. Aigner et al. (1977) and Meeuson and Broeck (1977) considered exponential half-normal distribution for u. Both have a zero mode. Stevenson (1980) had shown that the half-normal and exponential distributions can be generalized to truncated normal and gamma distributions respectively. Both these generalizations can have non zero mode with zero mode being testable as special case. Therefore u is assumed to be non-positive. So by taking truncated normal and normal distributions of u_i and v_i respectively.

$$f(u_i) = \begin{cases} \dfrac{1}{\sigma_u \cdot \sqrt{\dfrac{1}{2\pi}}} \cdot \exp\left(\dfrac{-u_i^2}{2\sigma_u^2}\right) & \text{if } u_i \leq 0 \\ 0 \quad \text{otherwise} \end{cases} \qquad \ldots (6)$$

and

$$f(v_i) = \frac{1}{\sigma_v \cdot \sqrt{\dfrac{1}{2\pi}}} \cdot \exp\left(\frac{-v_i^2}{2\sigma_v^2}\right) \quad -\infty < v_i < \infty \qquad \ldots (7)$$

The likelihood function of y is the product of density function of each y_i which is equal to the density function of $(u_i + v_i)$. By convolution formula the joint density function of $(u_i + v_i)$ could be written as:

$$f(u_i + v_i) = \frac{1}{\sqrt{\left(\dfrac{1}{2\pi}\right)(\sigma_u^2 + \sigma_v^2)}} \cdot \exp\left[\frac{(u_i + v_i)^2}{2(\sigma_u^2 + \sigma_v^2)}\right] \cdot \left[1 - F\left\{(u_i + v_i)\frac{\sigma_u}{\sigma \cdot \sigma_v}\right\}\right] \qquad \ldots (8)$$

where

1. F(.) is the cumulative distribution function of the standard normal random variable.

2. $\sigma^2 = \sigma_u^2 + \sigma_v^2$

3. $\gamma = \dfrac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}$ where γ lies in the interval (0,1)

4. $u_i + v_i = w_i = y_i - \Sigma x_{ij} \beta_j$

Using this notation the density function of y_i is defined in equation (8) may be written as

$$f(y_i) = \frac{1}{\sigma\sqrt{\frac{\pi}{2}}} \cdot \exp\left(\frac{w_i^2}{2\sigma^2}\right) \cdot \left[1 - F\left(\frac{w_i}{\sigma} \cdot \sqrt{\frac{\gamma}{1-\gamma}}\right)\right] \qquad \text{... (9)}$$

The parameterisation γ in the density function of y_i differs from λ, the one used by Aigner and others. The advantage of using γ is that it varies between 0 and 1 while λ varies from 0 to ∞. So the complete range of the parameter λ from 0 to ∞ could be explored to find the frontier function. But with γ trials are limited between 0 and 1, γ is an indicator of relative variability of u_i and v_i that differentiates the actual yield obtained from maximum feasible yield. There are two interesting points about γ.

1. When σ_v^2 is tending to zero, which implied that u_i is the predominant error in (3) and then $\gamma = 1$. This means that the farm's yield differed from maximum feasible yield mainly because it did not use the best practice technique.

2. When σ_u^2 is tending to zero, which implied that the symmetric error v_i is the predominant error in (3) and then γ is tending to zero. This means that the farm's yield differed from maximum feasible yield mainly because of either statical errors or external factors not under its control.

The likelihood function which is the probability density of obtaining the sample $(y_1, y_2, \ldots y_n)$ may be written as

$$L(y,\theta) = \prod_{i=1}^{n} \frac{1}{\sigma\sqrt{\frac{\pi}{2}}} \cdot \left[1 - F\left\{\frac{(y_i - \Sigma\beta_i x_{ij})}{\sigma \cdot \sqrt{\frac{\gamma}{1-\gamma}}}\right\}\right] \cdot \exp\left[-\frac{1}{2} \cdot \frac{(y_i - \Sigma\beta_j x_{ij})^2}{\sigma^2}\right] \qquad \text{... (10)}$$

where θ is the parameter to be estimated which contains the elements $(\beta_0, \beta, \sigma^2, \gamma)$. Since the natural logarithm of a function has the maximum point at the same position as the original function, taking logarithm of the likelihood function L,

$$\ln L = -\frac{n}{2}\ln\frac{\pi}{2} - \frac{n}{2}\ln\sigma^2 - \Sigma\ln[1 - F(z_i)] - \frac{(1-\gamma)}{2\gamma}\Sigma z_i^2 \qquad \text{... (11)}$$

where $z_i^2 = (y_i - \Sigma\beta_j x_{ij}) \cdot \left[\frac{\gamma}{(1-\gamma)\sigma^2}\right]^{\frac{1}{2}}$

Maximizing the above likelihood function the ML estimators of θ are obtained by setting its first order partial derivatives with respect to the elements of θ, namely β, σ^2, γ equal to zero and solving them simultaneously (Details vide in Appendix – II).

Now, in the present study the Cobb Douglas function given (1) becomes.

$$Y = f(x) \cdot \exp(w + \beta_7 D) \qquad \text{... (12)}$$

where $f(x) = A \cdot X_{i1}^{\beta_1} X_{i2}^{\beta_2} X_{i3}^{\beta_3} X_{i4}^{\beta_4} X_{i5}^{\beta_5} X_{i6}^{\beta_6}$

On natural logarithm, it becomes.

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \beta_5 X_{i5} + \beta_6 X_{i6} + \beta_7 D + w$$

where

β_0 = log A

Y_i = logarithm of milk yield per milch animal per lactation of the i^{th} farm (Rs.)

X_{i1} = logarithm of value of green fodder per milch animal per lactation of the i^{th} farm (Rs.)

X_{i2} = logarithm of value of dry fodder per milch animal per lactation of the i^{th} farm (Rs.)

X_{i3} = logarithm of value of concentrate per milch animal per lactation of the i^{th} farm (Rs.)

X_{i4} = logarithm of labour cost per milch animal per lactation of the i^{th} farm (Rs.)

X_{i5} = logarithm of cost of health care per milch animal per lactation of i^{th} farm

X_{i6} = logarithm of herd size in numbers

D = 0 for buffaloe ; 1 for crossbred cow

LINEAR PROGRAMMING MODEL

Linear programming technique is widely used because of its several advantages over functional anayasis. Functional analysis assumes continuous availability of resources where as programmes involve changes in resource levels, can not be handled by functional analysis and determination of normative plans with resource inequalities appears to be impossible through functional analysis. Hence linear programming technique which over comes the above lacunae of functional analysis was chosen.

Linear programming model was used to develop optimum plan for efficient utilisation of available resources at farm level. The objective function of the model was to maximise net income at farm level treating land, labour, green fodder, dry fodder, concentrate and cost on health care as constraints.

Selection of Representative or Typical Farms

To be more realistic, a typical farm was identified to represent the farming situations. Hence, it was necessary to identify farms which could represent the particular situation, which could by and large match the other farms in terms of farm size and other resource endowments. In the present study, the average operational area of farms in each size group was considered, while selecting the representative farm in each category of farms.

The data collected were carefully analysed with regard to land and other resources available and used by the farms, besides farm organisation and crop particulars. Then, four categories of farmer viz., landless, marginal farmer, small farmer and large farmer were identified. Programming matrix was formulated using sample data for each of the category in respect of feasible activities, resource constraints and technological coefficients.

Objective Function

The objective function was to maximise the net income from dairy and crop activity subject to technical constraints and level of resource availability.

The model

$$\text{Maximise } Z = \sum_{j=1}^{n} C_j X_j$$

$$\text{Subject to } \sum_{j=1}^{n} a_{ij} X_j \leq b_i$$

$$(i = 1, 2 \ldots\ldots\ldots m)$$

$$X_j \geq 0 \qquad (j = 1, 2 \ldots\ldots\ldots n)$$

Where, Z = Net income from dairy and crop activities

C_j = Value of j^{th} activity

X_j = Level of crop activity j

a_{ij} = Amount of i^{th} resource requirement to produce one unit of j^{th} activity

b_i = Available quantity of i^{th} resource level

m = Number of constraints

n = Number of activities

Selection of Crop Activities for Programming

In order to formulate optimum dairy with crop plan, it was necessary to select those crops which are technically and economically feasible with respect to available resources. All the crops which are more popular among the farmers were included in the programme. The selection was also based on factors like feasibility of growing them in different types of soil, input availability and market facilities. The unit used in defining these activities was one acre of harvested crop.

Thus Z would indicate the annual net income from dairy and crop activities of the sample farms, subject to specified constraints which are discussed here under.

Resource Constraints

The ease of linear programming problem is justified on the fact that atleast some of the resources are limited in supply. The possible major constraints that included in the present study were land, labour, green fodder, dry fodder, concentrate and cost on health care.

Land Constraints: Land is a scarce and limited in supply, was condidered as a seperate activity.

Labour Constraints: Labour was a very limiting resource in the study area and hence it was considered as constraints.

Feed Constraints: Here the feed included green fodder, dry fodder and concentrate. Feed is an important factor in milk production. Feed cost alone accounted for more than 50 per cent of the total cost of milk production and concentrate constituted major share in the feed cost. Hence, green fodder, dry fodder and concentrate were considered as constraints.

Cost on Health Care: Cost on health care also influenced the milk production. Hence it was considered as constraint.

Input Coefficient

The technological matrix is composed of input coefficients which are the resource requirements per unit of the process or activity included in the programme. The meaningfulness of any programme depends on the accuracy of the input coefficients for the enterprises that were being adopted in the representative farm, the input coefficients were computed from the data collected. The input coefficients were obtained separately for the farm situations in marginal farmer, small farmer and large farmer.

Resource Availability

Once the requirement of the resources for each crop activity and the restrictive resources were identified, it was necessary to assess the quantity of these resources available. These constituted the 'B' column of the programme. For the present analysis, the resources available in the representative farms in marginal farmer, small farmer and large farmer were taken as resource supply for the respective programmes.

Sensitivity Analysis

Programming was first done with the existing resources only. To capture the effect of possible fluctuations in resource availability, programming was run with changed resource levels for the green fodder and concentrate. Based on the compound growth rates of both green fodder and concentrates during the past 10 years, a ten were effected individually for cross bred cow and buffalo to draw optimal plans for various categories of farmers in the selected blocks. This exercise helped to highlight the policy induced effect on the proposed optimum plans.

Garett's Ranking Technique

For priortising the constraints in buffalo and cross bred cow milk production and identifying the most binding and important ones, Garett's ranking technique was used. In the normally distributed population, the ranks assigned to each category were converted into scores. Using per cent position for each of the assigned rank by using the formula.

$$\text{Per cent position} = \frac{100\ (R_{ij} - 0.05)}{N_j}$$

Where,

R_{ij} – Rank assigned for the i^{th} category by the j^{th} individual.

N_j – Number of reasons assigned by the j^{th} individual.

The mean of the scores were arrived by using the table developed by Garett. The means are ranked by arranging them in descending order.

DESCRIPTION OF THE STUDY AREA

CHAPTER IV

DESCRIPTION OF THE STUDY AREA

Socio-economic setting for every location is unique in its own character. For better understanding of the farm economic dynamics of a specific locality, the knowledge on various aspects that has an important role in the local agricultural economy, the agrarian culture and the society is essential. In this chapter an attempt is made to provide an insight into the background of the study area.

Location

Dharmapuri district lies between 11°45' and 13°01'north latitude and 77°13' and 78°45' east longitude covering an area of 9629.89 sq.km. This constitutes 7.4 per cent of the total geographical area of Tamil Nadu. The district is one of the border districts of the state, bounded by Malur of Karnataka state and Kuppam of Andhra Pradesh on the north; by Bangalore of Karnataka state on the west; by Vaniambadi, Tirupattur and Thiruvanamalai of North Arcot Ambedkar district on the east and by Salem district on the south. The elevation of the district ranges from 427 to 915 m above mean sea level. The district was constituted as an independent one with effect from October 2, 1965 by separating the northern taluks of Salem district.

Taluks and Blocks

The district with three revenue divisions viz., Dharmapuri, Krishnagiri and Hosur, composed of eight taluks, and each taluk is considered as an agricultural division. Further, the district is divided into 18 panchayat unions, consisting of 1,106 villages. There are 18 town panchayat and 588 village panchayats in the district.

Geographical Features

The district can be divided into two distinct geographical regions viz., i) a hilly region with elevation of more than 915 m above mean sea level known as 'Nalaghat region' comprising Hosur, Denkanikottah and parts of Krishnagiri taluk and ii) the 'Barmahal region', otherwise known as, the Dharmapuri plains, formed with taluks of Dharmapuri, Palacode, Uthangarai, Harur and Ponnagaram with an average elevation of more than 396 m above mean sea level. The topography in most part of the district is highly undulating plains with massive rocky out-growth occurring everywhere.

Demography

Population rose to 24.30 lakhs in 1991 from 19.90 lakhs in 1981, registering 2.20 per cent annual growth. On the basis of 1991 census 51.50 per cent of the total population have been males, the remaining 48.50 per cent were females. The population density of the district has been 252 persons per sq.kms. in 1991 and 90.61 per cent of the population formed the rural residents. The number of male main workers constituted nearly 60 per cent of the total male population and the number of female main workers formed nearly 25 per cent of the total female population. Population and the break-up of main workers are presented in Table III & IV.

TABLE III
HUMAN POPULATION OF DHARMAPURI DISTRICT

Particulars	1981			1991		
	Males	Females	Total	Males	Females	Total
Rural	1809876	923195	886681	2197921	1132281	1065640
Urban	187184	96167	91017	230675	118390	112285
Total	1997060	1019362	977698	2428596	1250671	1177925

Source : Tamil Nadu – An Economic Appraisal, 1992-93. Evaluation and Applied Research Department, government of Tamil Nadu, Madras - 18.

TABLE IV
DISTRIBUTION OF MAIN WORKERS AMONG VARIOUS CATEGORIES IN DHARMAPURI DISTRICT

Categories	Males	Females	Persons
Cultivators	464066 (55.56)	363455 (61.06)	100611 (41.92)
Agricultural Labours	230077 (27.55)	113088 19.00)	116989 (48.75)
Household industry	15380 (1.84)	10172 (1.71)	5208 (2.17)
Other workers	125716 (15.05)	108529 (18.23)	17187 (7.16)
Total main workers	835239 (100.00)	595244 (100.00)	239995 (100.00)

Figures in parentheses represent the percentage of main workers in agriculture, household industry and other workers to total workers.
Source : Census of India, 1981, Series 20, Tamil Nadu.

Cultivators formed the major group of the work force constituting over 55 per cent of the total main workers, followed by agricultural labourers (27.55 per cent) and other workers (15.05 per cent). The persons employed in household industry formed a negligible per cent of the total work force. Likewise, the cultivator constituted over 61 per cent of the the total male workers. Nearly 50 per cent of the female work force was employed as agricultural labourers. In both the male and female categories, the percentage employed in house-hold industry to the total population was very small.

In this district only 28.62 per cent of the population were literates. The percentage of literacy was more in the males (38.55 per cent) as compared to the females (18.28 per cent).

Climate and rainfall

The climate in the district is generally hot and dry except in places bordering karnataka State. March to May is the hottest period of the year, the temperature reaching upto 39° C in April. The climate becomes cool during December to February and in January it touches the minimum of 20° C. The particulars of rainfall, and temperature and wind velocity are furnished in Table V and Table VI respectively.

TABLE V
SEASON-WISE DISTRIBUTION OF RAINFALL IN DHARMAPURI DISTRICT (in mm)

Year	South-West Monsoon period	North-East Monsoon period	Winter period	Hot weather period	Total
1985-86	434.0	268.9	1.3	163.4	867.6
1986-87	368.2	496.7	0.0	113.5	996.4
1987-88	497.4	261.8	0.6	152.4	912.2
1988-89	573.4	171.3	2.1	147.2	844.0
1989-90	416.7	343.6	2.3	83.6	846.2
1990-91	299.6	230.9	13.0	179.4	722.1
1991-92	364.5	409.3	10.3	109.1	893.2
1992-93	306.1	282.7	70.3	92.9	752.0
1993-94	411.6	270.7	–	227.6	809.9
Average Rainfall	407.94	303.99	11.10	141.01	849.29
Co-efficient of variation	21.53	32.34	204.44	32.72	9.78

Source: Assistant Director of Statistics, Dharmapuri.

TABLE VI
MONTHLY TEMPERATURE OVER YEARS IN DHARMAPURI DISTRICT

Months	Maximum temperature					Minimum temperature				
	1990	1991	1992	1993	1994	1990	1991	1992	1993	1994
January	29.4	30.5	31.0	28.6	35.0	18.4	15.0	16.0	16.3	20.0
February	32.7	33.5	32.0	31.7	37.0	17.9	16.0	22.0	17.4	20.0
March	36.5	37.5	38.0	34.9	37.0	20.9	17.5	10.5	20.1	17.0
April	36.5	39.5	39.0	36.5	41.0	24.5	20.0	21.0	24.3	17.0
May	37.5	40.0	40.5	36.8	41.0	25.2	22.0	23.0	24.3	22.0
June	35.0	37.0	34.0	37.0	39.0	24.7	22.5	21.9	22.0	22.0
July	34.0	35.0	32.6	36.0	31.0	23.9	21.5	21.1	23.0	22.0
August	33.5	33.5	32.5	36.0	30.0	23.5	21.0	20.1	23.0	22.0
September	33.7	33.0	30.4	37.0	29.0	23.5	20.5	19.8	22.0	22.0
October	32.4	34.0	30.8	35.0	29.0	22.7	29.0	19.6	20.0	22.0
November	30.8	32.0	27.7	34.0	27.0	22.2	17.5	18.8	19.0	21.0
December	31.2	29.5	28.0	32.0	25.0	20.0	16.5	17.8	19.0	18.5

Source: Assistant Director of Statistics, Dharmapuri District.

The district receives an average rainfall of 849.29 mm and is mainly concentrated during the south-west monsoon. The average rainfall during south-west monsoon for the last nine years amounted to 407.94 mm with 24 rainy days and during the north-east monsoon it was 303.99 mm with 17 rainy days, the rest being distributed during summer months. The number of rainy days in the district ranges from 23 to 75, the average being 48 days. The wind velocity increases from about 7 km per hour in May to nearly two times during the months of June, July and August and comes down during September.

Soils

The soils of the district are of residual type formed by withering rocks. They are generally shallow in depth and do not exceed two meters in depth in Krishnagiri, Uthangarai and Harur taluks. They are poorly developed red to brown colored loams. In Hosur taluk the soil depth extends upto 7 to 8 meters. An entirely different patch of black clay soils occurs in the western border of Dharmapuri taluk.

Of the total area in the district, Vannapatti soil series cover about 39 per cent. They are yellowish-red to red in colour, non-calcareous and neutral. The soils are subjected to moderate to severe erosion and have good drainage and moderate permeability. The depth of the water table in these soils range from 15-20 m. The next major type is Hosur series which covers about 11 per cent of the total area. The Hosur, Onnapatti, Mathigir and Sonipuram soil series are calcareous and alluvial in nature and occupy 15 per cent of the total area. Krishnagiri, Mariyanpatti and Shoolagiri soil series are calcareous brown soils. Harur, Natham and Dharmapuri soil series are black calcareous soils. Kelamangalam soil series is brown in colour and the area under different soil types are presented in Table VII

TABLE VII
DIFFERENT SOIL TYPES OF DHARMAPURI DISTRICT

Soil type	Area in sq.km	Percentage
Red non-calcareous	5185	53.91
Brown non-calcareous	145	1.50
Brown calcareous	284	2.94
Black calcareous	457	4.75
Alluvial non calcareous	225	2.30
Reserve Forests	3323	34.60
Total	9619	100.00

Source: Assistant Director of Statistics, Dharmapuri

With regard to fertility status of the soils on nutrients basis, nitrogen is low in all the 16 blocks. The phosphorous content is low in Krishnagiri, Kaveripattinam, Palacode and Pennagaram blocks, while it is high in all the other blocks. Except Pappireddipatty block, all the other blocks are found to be rich in potassium.

Land Utilisation Pattern

The land utilisation pattern of Dharmapuri district, on an average, over the years (1990-91 to 1994-95) is presented in Table VIII. The total geographical area of the district is 9,62,913 ha. Net area sown accounted for over 42.37 per cent of the total geographical area and nearly seven per cent of the total geographical area was sown more than once. Barren and uncultivable wastes formed 7.94 per cent. Nearly six per cent of the area was put to non-agricultural uses and an equal proportion of area remained under current fallows. The cultivable waste lands amounting to 11,264 ha offers potential for horticultural development. A distinct feature of the land utilisation pattern of Dharmapuri district is that nearly 34 per cent of the total area is under forests.

TABLE VIII
LAND UTILISATION PATTERN IN DHARMAPURI DISTRICT
(Average of 1990-91 to 1994-95)

Particulars	Area in ha	Percentage to total
Forests	324699	33.72
Barren and uncultivable land	76488	7.94
Land put to non-agricultural/use	57275	5.95
Cultivable waste	11264	1.17
Permanent pastures and grazing lands	12085	1.26
Land under miscellaneous tree crops and groves not included in the net area sown	8252	0.86
Current fallows	54425	5.65
Other fallows	10403	1.08
Net area sown	408024	42.37
Total geographical area	962913	100.00
Area sown more than once	66544	6.91
Gross cropped area	474568	–

Source: Assistant Director of Statistics, Dharmapuri.

GROUP WISE DISTRIBUTION OF OPERATIONAL LAND HOLDINGS IN DHARMAPURI DISTRICT

The group-wise distribution of agricultural holdings is presented in Table IX. It can be observed that the largest percentage of the holdings are in the size group of 1.01 to 3.00 ha occupying nearly 39 per cent of the total area. Nearly 40 per cent of the holdings are in the size group of 0.01 to 1.0 ha occupying over 10 per cent of the total area. Nearly 82 per cent of the holdings are less than 3 ha cultivating over 49 per cent of the area while 1.28 per cent of the holdings above 10 ha are cultivating 9.40 per cent of the area, indicating the unequal ownership position. In General, small holdings predominate in the district.

TABLE IX
GROUP-WISE DISTRIBUTION OF OPERATIONAL LANDHOLDINGS IN DHARMAPURI DISTRICT

Size of holdings in ha	Approximate number of holding	% to total holdings	Total area holdings in ha	Percentage to total area
0.01 to 1.0	91337	39.72	47,841.24	10.76
1.01 to 3.00	97,652	42.46	1,72,683.25	38.81
3.01 to 5.00	24.885	10.82	94,793.90	21.30
5.01 to 10.00	13,161	5.72	87,805.68	19.73
10.01 and above	2,900	1.28	41,844.84	9.40
TOTAL	2,29,935	100.00	4,44,968.91	100.00

Source : Assistant Director of Statistics, Dharmapuri

Irrigation

The district is mainly dry and the percentage of net area irrigated is only 16 per cent as compared to 43.20 per cent for the State. There are two major rivers, Cauvery and South Pennar flowing through the district, but Cauvery does not provide for any irrigation in the the district. The South Pennar runs for about 149 km cutting across the district, north-west to south-east. There are seasonal rivers, Chinar, Vaniar, Thoppaiyar, Palar, Varattiar and Pambar which carry flushes during the rainy seasons and as such are not assured irrigation sources. About 80 per cent of the canal irrigated area lies in Krishnagiri taluk and area under River basin within the district is presented in Table X.

TABLE X
AREA UNDER RIVER BASIN IN DHARMAPURI DISTRICT

Name of the River	Area in Hectare
Cauvery	Nil
South Penniar	9065
Chinnar	4500
Pambar	4000
Vaniyar	10517
Nagavathi	1993
Thoppiar	5330

Source: Executive Engineer, PWD, Dharmapuri.

Most of the taluks depend on wells and tanks, which irrigate more than 85 per cent of the total irrigated area. There are 137644 masonry wells and 3476 tube wells in the district. There are 2111 irrigation tanks, majority of which are very small in size with command area of less than 40 ha.

The total area irrigated by wells, as well as its proportional coverage increased over years indicating the tendency among farmers to intensify farming activities by increased use of land and water. More than 66 per cent of the irrigated area gets benefited by wells and canals cover 10.00 per cent of the net irrigated area.

Cropping Pattern

The percentage of area sown under different crops to the total cropped area did not exhibit any significant difference over the years. Food crops continue to occupy more than 80 per cent of the gross cropped area. Among the food crops Paddy, Ragi, Cholam and horsegram formed nearly 55 per cent. Among the non-food crops groundnut occupied a major share in acreage (65 per cent).

Denkanikottah taluk had the maximum area under cereals followed by Harur and Krishnagiri taluk. Pulses covered large acreage in Hosur and Harur taluks covering nearly 45 per cent of the acreage under pulses. Among pulses horsegram occupied major share with more than 85 per cent of acreage under pulses. Among non-food crops groundnut was concentrated in Uthangarai, Krishnagiri and Palacode taluks having nearly 80 per cent of the area under the crop. Cotton and sugarcane formed the other major non-food crops distributed in the different taluks except Hosur.

The total area under fruits and vegetables in the district formed 9.6 per cent of the net area sown as against 4.75 per cent in State. Mango occupied more than 50 per cent of the area under the horticultural crops with 10755 ha and formed more than 31 per cent of the area under the crop in the State. Grapes and guava formed 18 per cent and 11 per cent of their areas at the State level and held the second place as regards the acreage. Though banana was raised in 2194 ha, it was only eleventh in rank as regards the area under the crop in the State. The total area under the fresh fruits covered nearly eight per cent of the State's area under these crops and the district ranked third in the State with regard to the area.

Tapioca, potatoes and cabbage formed the major vegetables and root crops of the district, with 6 per cent of their acreage in the State.

Tamarind, widely used as a condiment, occupied an area of 1354 ha and covered nearly 15 per cent of the State's acreage. The district ranked third in acreage under the crop in the State. The area and production of selected crops are presented in Table XI

TABLE XI

AREA AND PRODUCTION OF SELECTED CROPS IN DHARMAPURI DISTRICT FOR THE YEAR 1993 - 94

Crop	Area (in hectare)	Production (in tonnes)
Paddy	54812	174025
Cholam	46226	67000
Ragi	79080	159662
Sunflower	11203	7763
Cotton	13670	31262
Sugarcane	14035	192486
Tapioca	10284	427415

Source : Directorate of Agriculture, Chepauk, Madras-5.

CATTLE RESOURCES

The livestock population of Dharmapuri district is presented in Table XII.

TABLE XII

LIVESTOCK POPULATION OF DHARMAPURI DISTRICT

Livestock	Population
Cattle	518226
Buffaloes	109551
Goats	218622
Sheep	385625
Pigs	18349
Dogs	80243*
Others	5269
Total Livestock	1335885
Total Poultry	849655

Source : Director of Animal Husbandry, Madras- 35.

* Includes donkey, horses, ponies, mules and camels

The Department of Animal Husbandry provides health cover for the livestock with the following infrastructure presented in Table XIII.

TABLE XIII
LIST OF VETERINARY INSTITUTIONS IN DHARMAPURI DISTRICT

Particulars	Number
Veterinary Hospitals	2
Veterinary Dispensaries	41
Mobile Veterinary units	5
Clinician centre	2
Veterinary Doctors	55
Veterinary livestock inspectors	87

Source : Annual Administration Report, Animal Husbandry Department, Government of Tamil Nadu, 1993 - 95.

The Various rural development programmes sponsored by both central and state government in Dharmapuri district are presented in Table XIV.

TABLE XIV
RURAL DEVELOPMENT PROGRAMMES

Small farmers development agencies
Drought prone area project
Integrated rural development programme
Command area development programme
Integrated tribal development project
Hill area development project
Calf rearing scheme
Intensive cattle development project
Rural artisans programme
Rural industries programme
Fodder development programme

Source: Assistant Director of Statistics, Dharmapuri.

ROLE OF DHARMAPURI DISTRICT CO-OPERATIVE MILK PRODUCER'S UNION (DDCMPU)

The Dharmapuri district co-operative milk producer's union playing a major role in dairy development by providing various infrastructure and the activities of the DDCMPU are presented in Table XV and XVI.

TABLE XV
VETERINARY CARE, NUMBER OF MILK SOCIETIES AND MILK PROCUREMENT OF DDCMPU

	1990-91	91-92	92-93	93-94	94-95
No. of cases treated	46180	63944	97907	67811	36900
No. of AI done	43059	59202	61787	60894	60990
No. of Calves borne	11712	11688	12923	11820	12671
No. of Emergency cases treated	409	149	117	141	173
No. of Societies	623	627	602	612	620
Milk production/day (lit.)	80654	75668	80940	89944	92886
Total members	155338	160264	159298	164358	165593
Feed (tonnes)	1919	1443	1504	1101	1540

Source: DDCMPU, Krishnagiri

TABLE XVI
MILK PRODUCTS PRODUCED AND MARKETED BY DDCMPU

Milk Products	P	M	P	M	P	M	P	M	P	M
Milk (lakh lit.)	388	253	276	242	295	257	328	246	339	293
Milk powder (tonnes)	910	1176	388	471	669	204	1449	1369	962	1062
Butter (tonnes)	966	859	797	746	580	493	1348	392	1595	520
Ghee (tonnes)	373	375	174	251	74	89	948	924	752	758
Khoa (kg.)	5648	5644	5137	5141	7065	7040	8770	8768	12610	12616
Flavoured milk (lit.)	6379	6295	9244	9279	10518	10386	2024	2091	4561	4554

Source: DDCMPU, Krishnagiri.

Infrastructural Facilities

The major market centers in the district are Dharmapuri, Krishnagiri and Hosur and the important agricultural commodities transacted are paddy, ragi,cholam, horsegram, groundnut, gingelly, mango and tamarind. Krishnagiri, is the main centre for tamarind and mango. The details of marketing facilities available in the district are presented in Table XVII.

Table XVII
MARKETING FACILITIES IN DHARMAPURI DISTRICT

Particulars	Number
Shandies	75
Primary Markets for horticultural crops and terminal markets	27
Wholesalers	183
Commission agents	28
Co-operative marketing societies	7
Regulated markets	10

Source : Assistant Director of Statistics, Dharmapuri

There are 75 shandies in Dharmapuri district which serve as important marketing centers besides 27 primary and terminal markets for horticultural crops. The Dharmapuri district Market Committee was constituted in 1970 and has established regulated markets at ten centers viz., Krishnagiri, Royacottah, Kelamangalam, Hosur, Palacode, Pennagaram, Dharmapuri, Pochampalli, Harur and Uthangarai. Groundnut, tamarind, cane-jaggery, gingelly, paddy and cotton are notified commodities. These market yards have not been able to attract arrivals due to the overriding influence of the commission agents and merchants on the farmers. Though tapioca and potato also formed the notified crops farmers did not bring these commodities to the regulated markets.

Financial Institutions

The distribution of financial institutions in Dharmapuri district is given in Table XVIII and these institutions provided financial assistance to the farmers in the form of short term loans for purchase of livestock, seeds, fertilizers and for other cultivation operations; medium and long-term loans for minor irrigation works, establishments of orchards, purchase of agricultural machinery and implements, starting of dairy, poultry, sheep and goat farms.

TABLE XVIII
FINANCIAL INSTITUTIONS IN DHARMAPURI DISTRICT

Institution	No.of Branches
State Bank of India	6
Indian Bank	9
Central Bank of India	2
Indian Overseas Bank	3
Bank of Baroda	1
Syndicate Bank	1
Land Development Bank	1
District Central Co-operative Bank	1
Total	24

Source: Assistant Director of Statistics, Dharmapuri.

Transport and Communication facilities

The Railway broad guage line connecting Madras and Salem runs through the district in Uthangarai taluk for a distance of 58 km with one important station at Morappur. The metre gauge railway line connecting Salem and Bangalore roads through the district for a distance of 122 km touching Dharmapuri, Palacode, Royakottah, Kelamangalam and Hosur. The details are furnished in Table XIX.

TABLE XIX
TRANSPORT AND COMMUNICATION FACILITIES IN DHARMAPURI DISTRICT (1994)

Particulars	Distance in Km.
Railways	
Broad gauge	58.00
Metre gauge	122.00
Total	180.00
Roads	
National Highways	157.00
State Highways	5.00
Total	162.00
District Roads	1140.00
Panchayat Union Roads	733.00
Panchayat Roads	963.00
Total	2836.00
Surfaced Roads	
Cement concrete	17.00
Black topped	1312.00
Total	1329.00
Water bound	1567.00
Unsurfaced	1351.00
Total	7425.00

Source: Assistant Director of Statistics, Dharmapuri.

During 1993 cement concrete roads covered a distance of 17.00 km in the district. National Highways, both NH 7 and 46 pass through this district and 1140 km are classified as major district roads. Length of roads per sq.km. is only 0.8 km which is far below the national average of 1.8 km. The overall riding surface quality of roads is poor and there are many places inaccessible to public transport system indicating inadequate transport facilities.

RESULTS AND DISCUSSION

CHAPTER V

RESULTS AND DISCUSSION

A brief review of the related past studies, relevant methodology adopted and the general description of the study area were presented in the earlier chapters. With that, the data were collected during the survey were tabulated and analysed in relation to each of the specific objectives of the study. The results of the analyses are presented and discussed in this chapter and specific inferences were drawn under the following headings.

1. Characteristics of the sample farmers
2. Costs and returns of the dairy and crop enterprises
3. Resource productivity in dairy
4. Optimal plans for income maximisation
5. Constraints in milk production

1. CHARACTERISTICS OF SAMPLE FARMERS

A brief description of the characteristics of the sample farms would provide the backdrop for the discussion. Therefore, the blockwise distribution of different categories of farmer, average size of holding, family size, literacy level, categorywise asset position, distribution of milch animals and the composition of bovine stock in the sample farms are discussed.

i. Distribution of Sample Farmers

Post stratification of 360 respondents resulted in 24.72 per cent of land less labourers, 24.17 per cent of marginal farmers, 27.50 per cent of small farmers and 23.61 per cent of large farmers. The blockwise distribution of sample farmers are presented in Table XX.

TABLE XX

DISTRIBUTION OF SAMPLE FARMERS ACCORDING TO LAND HOLDING

Categories of farmer	Block I	Block II	Block III	Total
Landless labourer (LL)	31 (23.66)	32 (27.12)	26 (23.42)	89 (24.72)
Marginal farmer (MF)	31 (23.66)	26 (22.03)	30 (27.03)	87 (24.17)
Small farmer (SF)	40 (30.54)	31 (26.27)	28 (25.23)	99 (27.50)
Large farmer (LF)	29 (22.14)	29 (24.58)	27 (24.32)	85 (23.61)
Total	131 (100.00)	118 (100.00)	111 (100.00)	360 (100.00)

(Figures in parentheses indicate percentage to total).

ii. Operational Holdings and Family Size

The average size of holdings worked out to 2.46, 4.67 and 6.71 acres for block I, 2.15, 4.15 and 6.59 acres for block II and 1.37, 3.57 and 5.98 acres for block III among marginal, small and large farmer categories respectively. The average family size was found to be 4.3, 4.5, 4.6 and 4.0 for block I, 5.1, 4.6 and 4.1 for block II and 4.5, 4.4, 4.5 and 4.1 for block III among landless, marginal small and large farmer categories respectively which are presented in Table XXI.

iii. Educational Status

The standard of education moulds the farmer's response to improve technology and market performance, since enlightened farmers have a higher motivation to supply milk, to diversify farm business and to earn more. This is especially true of dairy farming which warrants a better quality of management input than the traditional crop farming. Educational status of the farmer influences his decision behaviour to a great extent. Hence, the details on the same were collected, analysed and the results are presented in Table XXII.

It could be seen from the table that 92.50 per cent of the sample farmers were literates, while 7.50 per cent of the farmers were illiterates. The percentage of illiteracy was the maxmimum in block II for landless category followed by block III and block I where as in case of large farmers all were literate and the percentage of graduate education was the maximum in block I (55.17) followed by block II (37.93) and block III (33.33). It clearly indicates that as the size of holding increased, farmers educational level also increased. In sum, majority of the farmers were literates and this was a good sign for the better diffusion of innovations and new technologies among the farmers.

TABLE XXI

OPERATIONAL HOLDING AND FAMILY SIZE OF SAMPLE FARMERS

Block	Categories of farmer	Average family size (in numbers)	Average size of landholding (*in acres*)
I	LL	4.3	–
	MF	4.5	2.46
	SF	4.6	4.67
	LF	4.0	6.71
II	LL	5.1	–
	MF	4.6	2.15
	SF	4.6	4.15
	LF	4.1	6.59
III	LL	4.5	–
	MF	4.4	1.37
	SF	4.5	3.57
	LF	4.1	5.98

TABLE XXII

EDUCATIONAL STATUS OF THE HEAD OF SAMPLE FARMERS

Particulars	Block I				Block II				Block III				Overall
	LL	MF	SF	LF	LL	MF	SF	LF	LL	MF	SF	LF	
Educational Status:													
Illiterate	2 (6.45)	–	–	–	9 (28.13)	2 (7.69)	3 (9.68)	–	7 (26.92)	4 (13.33)	–	–	27 (7.50)
Primary	2 (6.45)	2 (6.45)	3 (7.50)	–	6 (18.75)	5 (19.23)	3 (9.68)	–	5 (19.23)	4 (13.33)	6 (21.43)	4 (14.81)	40 (11.11)
Secondary	6 (19.35)	8 (25.81)	6 (15.00)	2 (6.90)	10 (31.25)	4 (15.38)	3 (9.68)	7 (24.14)	5 (19.23)	9 (30.00)	6 (21.43)	3 (11.11)	69 (19.17)
Higher Secodnary	10 (32.26)	8 (25.81)	12 (30.00)	5 (17.24)	3 (9.37)	7 (26.93)	9 (29.03)	6 (20.69)	8 (30.77)	9 (30.00)	7 (25.00)	6 (22.22)	90 (25.00)
Graduate	8 (25.81)	10 (32.25)	14 (35.00)	16 (55.17)	4 (12.50)	6 (23.08)	9 (29.03)	11 (37.93)	1 (3.85)	3 (10.00)	6 (21.43)	9 (33.33)	97 (26.94)
Post-graduate	3 (9.68)	3 (9.68)	5 (12.50)	6 (20.69)	–	2 (7.69)	4 (12.90)	5 (17.24)	–	1 (3.34)	3 (10.71)	5 (18.53)	37 (10.28)
Number of households	31 (100.00)	31 (100.00)	40 (100.00)	29 (100.00)	32 (100.00)	26 (100.00)	31 (100.00)	29 (100.00)	26 (100.00)	30 (100.00)	28 (100.00)	27 (100.00)	360 (100.00)

(Figures in parentheses indicate percentage to total)

iv. Asset Position of the Sample Farmers

The asset position of the sample farmers could serve as a measure of their economic viability and liquidity. This could influence the farm financial activities like investment on equipments and machinery, borrowing and repayment as well as the decision behaviour regarding extent of adoption of new technology. The composition of assets of the sample farmers are summarised in Table XXIII.

The pattern of asset distribution in block I showed that land accounted for more than 44.61 per cent of the total asset value in all the three categories of farmers. Buildings shared 21 to 29 per cent of the total asset value in marginal, small and large farmer categories followed by wells. Livestock activity was found to be high in marginal farmer (4.54 per cent).

In block II land accounted to the maximum of 59.69 per cent of the total asset value for large farmer where as wells, buildings and livestock formed the next major assets.

In block III also land accounted to the maximum of 83.61 per cent for large farmer, buildings accounted to the maximum of 16.54 per cent for marginal farmer, livestock, implements and machinery together amounted to more than 2.90 per cent of the total asset value for all the three categories of farmers.

Among the three blocks, the average asset value per farm was the maximum in block III. The share of land in total assets was also the maximum in block III. The values of machinery and tools and implements per farm were low and livestock per farm were comparatively high for all the categories of farmer in all the three blocks.

TABLE XXIII

CATEGORY WISE ASSET POSITION

(Rs. '000 / farm)

Particulars	Block I				Block II				Block III			
	LL	MF	SF	LF	LL	MF	SF	LF	LL	MF	SF	LF
Lands	–	104.08 (44.61)	221.59 (57.63)	326.36 (59.91)	–	102.96 (47.56)	212.58 (58.00)	301.92 (59.69)	--	241.47 (61.43)	602.82 (78.01)	1013.14 (83.61)
Wells	–	50.11 (21.48)	64.65 (16.81)	64.06 (11.76)	–	53.80 (24.85)	60.54 (16.52)	68.43 (13.53)	–	64.82 (16.49)	60.91 (7.88)	63.92 (5.28)
Buildings	22.75 (74.74)	67.86 (29.08)	81.36 (21.16)	124.78 (22.91)	24.90 (73.84)	41.49 (19.17)	70.35 (19.19)	101.12 (20.00)	48.15 (73.56)	65.01 (16.54)	80.81 (10.46)	98.79 (8.15)
Machinery	–	0.04 (0.02)	1.82 (0.48)	5.25 (0.96)	–	0.02 (0.01)	1.40 (0.38)	3.99 (0.79)	–	1.02 (0.26)	2.34 (0.30)	7.51 (0.62)
Tools and Implements	0.07 (0.23)	0.63 (0.27)	0.71 (0.18)	1.04 (0.19)	0.07 (0.21)	0.45 (0.21)	0.51 (0.14)	0.87 (0.17)	0.07 (0.10)	0.55 (0.14)	0.73 (0.09)	0.79 (0.07)
Livestock	7.62 (25.03)	10.60 (4.54)	14.39 (3.74)	23.27 (4.27)	8.75 (25.95)	17.75 (8.20)	21.14 (5.77)	29.46 (5.82)	17.24 (26.34)	20.22 (5.14)	25.11 (3.26)	27.56 (2.27)
Total	30.44 (100.00)	233.32 (100.00)	384.52 (100.00)	544.76 (100.00)	33.72 (100.00)	216.47 (100.00)	366.52 (100.00)	505.79 (100.00)	65.46 (100.00)	393.09 (100.00)	772.72 (100.00)	1211.71 (100.00)

(Figures in parentheses indicate percentage to total)

v. Composition of Bovine Stock

The structure of bovine stock in an area broadly indicates the distinctiveness of the scenario in which the dairy farming is undertaken. Table XXIV for this reason seek to unravel the profile of bovine stock maintained in the sample households.

It was observed that landless owned 89.93 per cent and 93.28 per cent of buffaloes followed by marginal, small and large farmers in blocks I and II respectively where as the distribution of cross bred cows was more to the tune of 86.73 per cent among large farmers followed by small, marginal and landless categories in that order in block III.

The analysis clearly indicated that buffaloes were preferred more among landless and marginal categories and cross bred cows were preferred more by large farmers indicating that buffaloes need less of resources and cross bred cows demand more resources. Among the selected farmers the distribution of buffaloes was found to be higher compared to cross bred cows in blocks I and II where as it was reverse in block III. This divulged the preference for buffaloes in blocks I and II and cross bred cows in block III. The distribution of milch animals and young stock was found to be more or less uniform among the different species in all categories of farmers except in block III for cross bred cows.

vi. Distribution of Milch Animals

Extent of rearing milch animals among the sample farms would help in under standing the extent of supplementary income earned by the sample farmers.

Total number of buffaloes and cross bred cows owned by each category of farmer were tabulated and presented in Table XXV.

COMPOSITION OF BOVINE STOCK

(in numbers)

Particulars	Block I				Block II				Block III			
	LL	MF	SF	LF	LL	MF	SF	LF	LL	MF	SF	LF
Bovine Heads												
A. Buffaloes	125 (89.93)	110 (80.29)	34 (26.56)	42 (26.75)	111 (93.28)	84 (71.79)	66 (57.89)	42 (31.11)	27 (29.35)	45 (38.46)	22 (20.75)	15 (13.27)
B. Cross bred cows	14 (10.07)	27 (19.71)	94 (73.44)	115 (73.25)	8 (6.72)	33 (28.21)	48 (42.11)	93 (68.89)	65 (70.65)	72 (61.54)	84 (79.25)	98 (86.73)
Total	139 (100.00)	137 (100.00)	128 (100.00)	157 (100.00)	119 (100.00)	117 (100.00)	114 (100.00)	135 (100.00)	92 (100.00)	117 (100.00)	106 (100.00)	113 (100.00)
Composition of Bovine Head												
A. Buffaloes												
Milch	64 (51.20)	68 (61.82)	22 (64.71)	28 (66.67)	71 (63.96)	53 (63.10)	47 (71.21)	25 (59.52)	18 (66.67)	27 (60.00)	18 (81.82)	8 (53.33)
Young stock	61 (48.80)	42 (38.18)	12 (35.29)	14 (33.33)	40 (36.04)	31 (36.90)	19 (28.79)	17 (40.48)	9 (33.33)	18 (40.00)	14 (18.18)	7 (46.67)
Total	125 (100.00)	110 (100.00)	34 (100.00)	42 (100.00)	111 (100.00)	84 (100.00)	66 (100.00)	42 (100.00)	27 (100.00)	45 (100.00)	22 (100.00)	15 (100.00)
B. Cross bred cows												
Milch	7 (50.00)	12 (44.44)	52 (55.32)	67 (58.26)	5 (62.50)	18 (54.55)	24 (50.00)	65 (69.89)	42 (64.62)	48 (66.67)	54 (64.29)	65 (66.33)
Young stock	7 (50.00)	15 (55.56)	42 (44.68)	48 (41.74)	3 (37.50)	15 (45.45)	24 (50.00)	28 (30.11)	23 (35.38)	24 (33.33)	30 (35.71)	33 (33.67)
Total	14 (100.00)	27 (100.00)	94 (100.00)	115 (100.00)	8 (100.00)	33 (100.00)	48 (100.00)	93 (100.00)	65 (100.00)	72 (100.00)	84 (100.00)	98 (100.00)

(Figures in parentheses indicate percentage to total)

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TABLE XXV

DISTRIBUTION OF MILCH ANIMALS AMONG DIFFERENT CATEGORIES OF SAMPLE FARMS

(in numbers)

Particulars	Block I				Block II				Block III			
	LL	MF	SF	LF	LL	MF	SF	LF	LL	MF	SF	LF
Buffaloes	64 (90.14)	68 (85.00)	22 (29.73)	28 (29.47)	71 (93.42)	53 (74.65)	47 (66.20)	25 (27.78)	18 (30.00)	27 (36.00)	18 (25.00)	8 (10.96)
Cross bred cows	7 (9.86)	12 (15.00)	52 (70.27)	67 (70.53)	5 (6.58)	18 (25.35)	24 (33.80)	65 (72.22)	42 (70.00)	48 (64.00)	54 (75.00)	65 (89.04)
Total	71 (100.00)	80 (100.00)	74 (100.00)	95 (100.00)	76 (100.00)	71 (100.00)	71 (100.00)	90 (100.00)	60 (100.00)	75 (100.00)	72 (100.00)	73 (100.00)

(Figures in parentheses indicate percentage to total)

In block I, landless and marginal farmers owned 90.14 per cent and 85.00 per cent of buffaloes where as small farmer and large farmer owned 70.27 per cent and 70.53 per cent of cross bred cows which reflected their full exploitation of the cross breeding technology in sharp contrast to the landless category at the other end of the spectrum.

In block II, the proportion of buffaloe was found to be more in landless, marginal and small farmers category where as it was less in case of large farmer category.

In block III, the proportion of cross bred cow was found to be more and the same was increased as the land holding increased in all the categories of farmer.

2. COSTS AND RETURNS IN MILK AND CROP PRODUCTION

i. Investment Pattern of Milk Producers

The farm asset structure plays a vital role in streamlining the productivity of dairy enterprise. The details about investment pattern on dairy enterprise as a whole decomposed into value of buildings, equipments and machinery, water and electricity installations and value of milch animals, species wise are presented in Table XXVI. Since dairy farming is practiced as a supplementary enterprise to arable farming, investment on land has not been considered in this study.

It could be seen from the Tables XXVI, XXVII and XXVIII that as for the buffaloes concerned the large farmers invested more for buildings to the tune of 10.73 per cent as compared to the other categories of farmers in all the blocks. The landless invested about 98 per cent on buffaloes followed by marginal farmers, small farmers and large farmers in that order for the blocks. In case of cross breds the landless category invested to the extent of 98.83 per cent towards milch animals for all the

TABLE XXVI

INVESTMENT PATTERN OF MILK PRODUCERS FOR BLOCK I

(Rs./animal)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Buildings	–	315.40 (5.74)	–	2615.81 (27.71)	410.11 (8.92)	2714.12 (25.00)	365.42 (7.39)	1684.85 (15.39)
Equipments and Machinery	44.60 (1.15)	65.72 (1.20)	61.40 (1.53)	110.25 (1.17)	68.74 (1.49)	115.66 (1.07)	70.44 (1.42)	132.42 (1.21)
Water and Electricity installations	–	–	8.15 (0.20)	14.20 (0.15)	7.90 (0.17)	16.37 (0.15)	9.41 (0.19)	18.11 (0.17)
Milch animals	3850.00 (98.85)	5110.15 (93.06)	3955.50 (98.27)	6700.47 (70.97)	4111.66 (89.42)	8010.42 (73.78)	4504.44 (91.00)	9109.60 (33.23)
Total Investment	3894.60 (100.00)	5491.27 (100.00)	4025.05 (100.00)	9440.73 (100.00)	4598.41 (100.00)	10856.57 (100.00)	4949.71 (100.00)	10944.98 (100.00)

(Figures in parentheses indicate percentage to total)
B – Buffaloe
CB – Cross bred cow

TABLE XXVII

INVESTMENT PATTERN OF MILK PRODUCERS FOR BLOCK II

(Rs./animal)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Buildings	-	-	-	648.75 (8.93)	315.42 (7.36)	755.84 (9.62)	375.63 (8.16)	1410.44 (15.16)
Equipments and machinery	38.42 (1.09)	64.66 (1.17)	55.65 (1.37)	101.79 (1.40)	59.41 (1.39)	115.62 (1.47)	75.75 (1.64)	130.71 (1.40)
Water and electricity installations	-	-	3.15 (0.08)	5.71 (0.08)	4.12 (0.10)	6.80 (0.09)	4.40 (0.10)	14.70 (0.16)
Milch animals	3475.15 (98.91)	5475.74 (98.83)	4010.61 (98.55)	6510.99 (89.59)	3904.75 (91.15)	6975.64 (88.82)	4150.33 (90.10)	7750.40 (83.28)
Total investment	3513.57 (100.00)	5540.40 (100.00)	4069.41 (100.00)	7267.24 (100.00)	4283.70 (100.00)	7853.90 (100.00)	4606.11 (100.00)	9306.25 (100.00)

(Figures in parentheses indicate percentage to total)

blocks and the proportion invested towards buildings was more among large farmers. The investment towards equipments and machinery was found to be less than 2 per cent and for water and electricity installations it was found to be less than 0.20 per cent among all categories of farmers which does not merit attention.

Among, the milch animals, cross bred cows commanded more investment compared to buffaloes. By and large the investment towards milch animals were more among landless category and less among large farmer category while the reverse was observed in case of investment on buildings for all the blocks which clearly indicated the housing management being practiced among the different categories of farmers.

ii. Maintenance Cost of Milch Animals

Dairying can not flourish unless the milk production becomes an economic proposition. The dairying can be operated on profitable basis by increasing the milk yield of bovines and supplying nutrients required for milk production at cheaper cost. Studies conducted so far unravel that the business of milk production under the existing rural scenario was nonremunerative or provided only marginal gains.

This has been largely attributed to, inter alia, nonremunerative price of milk vis-a-vis its cost of perdition. The profit margin can be raised, if the cost of production is kept at minimum and/or milk prices are raised sufficiently.

The estimation of cost incurred on maintenance of milch animals is of strategic significance while exploring the economic feasibility of commercial dairy enterprise. The estimates of maintenance cost besides indicating the extent of day to day expenses in dairying, could indicate the ways and means to taper down the cost of milk

TABLE XXVIII

INVESTMENT PATTERN OF MILK PRODUCERS FOR BLOCK III

(Rs./animal)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Buildings	–	420.50 (5.98)	115.43 (2.73)	1110.75 (12.70)	575.61 (10.38)	1975.20 (18.26)	645.71 (10.73)	2155.41 (17.63)
Equipments and machinery	60.44 (1.48)	104.55 (1.49)	62.73 (1.48)	115.20 (1.32)	60.41 (1.09)	121.42 (1.12)	62.66 (1.04)	140.25 (1.14)
Water and electricity installations	–	4.44 (0.06)	–	16.64 (0.19)	6.71 (0.12)	17.01 (0.16)	7.22 (0.12)	21.71 (0.18)
Milch animals	4010.44 (998.52)	6500.65 (92.47)	4050.62 (95.79)	7500.44 (85.79)	4900.12 (88.41)	8702.77 (80.46)	5300.14 (88.11)	9909.75 (81.05)
Total investment	4070.88 (100.00)	7030.14 (100.00)	4228.78 (100.00)	8743.03 (100.00)	5542.85 (100.00)	10816.64 (100.00)	6015.73 (100.00)	12227.12 (100.00)

(Figures in parentheses indicate percentage to total)

production. Keeping this in view, the maintenance cost of milch animals in the milk shed area was computed by adding the cost of feed, labour, medicines, assets, interest on fixed capital and miscellaneous expenses.

The total maintenance cost per milch animal per day and its break up according to different items of costs are presented in Table XXIX to XXXVII.

It could be seen from the Tables XXIX, XXX, XXXI that the interest on investment for buffaloe and cross bred cow was about 71 per cent and the depreciation on equipments and machinery was in the region of 0.52 per cent to 0.78 per cent for both buffaloe and cross bred cow for all the categories of farmers for all the three blocks. The depreciation on buildings was found to be more for cross bred than buffaloe irrespective of the farm size. The share of insurance in buffaloes and cross breds did not elicit any marked difference. In general, interest on investment occupied a major share among fixed cost components.

The total variable cost per milch animal per lactation was highest for cross bred cows compared buffaloes in all the blocks for all the categories of farmers and also it increased with increase in land holding which was evident from the Tables XXXII, XXXIII and XXXIV.

The share of green fodder was highest (42.12 per cent) for cross bred cow and for buffaloe it was 39.70 per cent for land less category of block I. Among the variable cost components the expenses towards concentrates were more in all the milch animals irrespective of the farm size.

TABLE XXIX

FIXED COST PER MILCH ANIMAL PER LACTATION FOR BLOCK I

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Interest on investment	584.19 (71.28)	823.69 (71.46)	603.76 (71.26)	1416.11 (72.24)	689.76 (71.56)	1628.49 (72.17)	742.46 (71.53)	1641.75 (71.82)
Depreciation on buildings	–	15.77 (1.37)	–	130.79 (6.67)	20.51 (2.13)	135.71 (6.01)	18.27 (1.76)	84.24 (3.69)
Depreciation on equiment and machinery	4.46 (0.54)	6.57 (0.57)	6.14 (0.73)	11.25 (0.57)	6.87 (0.71)	11.57 (0.52)	7.04 (0.67)	13.24 (0.58)
Insurance cost	231.00 28.18)	306.61 (26.60)	237.33 (28.01)	402.03 (20.52)	246.70 (25.60)	480.63 (21.30)	270.27 (26.04)	546.58 (23.91)
Total fixed cost	819.15 (100.00)	1152.64 (100.00)	847.23 (100.00)	1960.18 (100.00)	963.84 (100.00)	2256.40 (100.00)	1038.04 (100.00)	2285.81 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE XXX

FIXED COST PER MILCH ANIMAL PER LACTATION FOR BLOCK II

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Interest on investment	527.04 (71.28)	831.06 (71.27)	610.41 (71.26)	1090.09 (71.56)	642.56 (71.51)	1178.09 (71.57)	690.92 (71.50)	1395.94 (71.79)
Depreciation on buildings	–	–	–	32.44 (2.13)	15.77 (1.76)	37.80 (2.30)	18.78 (1.94)	70.52 (3.63)
Depreciation on equipment and machinery	3.84 (0.52)	6.47 (0.56)	5.57 (0.65)	10.18 (0.67)	5.94 (0.66)	11.56 (0.70)	7.58 (0.78)	13.01 (0.67)
Insurance cost	208.51 (28.20)	328.54 (28.17)	240.64 (28.09)	390.66 (25.64)	234.29 (26.07)	418.54 (25.43)	249.02 (25.78)	465.02 (23.91)
Total fixed cost	739.39 (100.00)	1166.07 (100.00)	856.62 (100.00)	1523.37 (100.00)	898.56 (100.00)	1645.99 (100.00)	966.30 (100.00)	1944.55 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE XXXI

FIXED COST PER MILCH ANIMAL PER LACTATION FOR BLOCK III

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Interest on investment	610.63 (71.23)	1054.52 (71.44)	634.32 (71.32)	1311.45 (71.73)	831.43 (71.66)	1622.50 (71.93)	902.36 (71.68)	1834.07 (71.91)
Depreciation on buildings	–	21.03 (1.42)	5.77 (0.65)	55.54 (3.03)	28.78 (2.48)	98.76 (4.38)	32.29 (2.56)	107.77 (4.23)
Depreciation on equipment and machinery	6.04 (0.70)	10.46 (0.72)	6.27 (0.70)	11.52 (0.63)	6.04 (0.52)	12.14 (0.54)	6.27 (0.50)	14.03 (0.55)
Insurance cost	240.63 (28.07)	390.04 (26.42)	243.04 (27.33)	450.03 (24.61)	294.01 (25.34)	522.17 (23.15)	318.01 (25.26)	594.59 (23.31)
Total fixed cost	857.30 (100.00)	1476.05 (100.00)	889.40 (100.00)	1828.24 (100.00)	1160.26 (100.00)	2255.57 (100.00)	1258.93 (100.00)	2550.46 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE XXXII

VARIABLE COST PER MILCH ANIMAL PER LACTATION FOR BLOCK I

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Feed cost:								
Green fodder	3129 (39.70)	3615 (36.83)	3250 (35.33)	3815 (30.58)	3275 (26.42)	3358 (24.46)	3650 (35.56)	3915 (27.98)
Dryfodder	1314 (16.67)	1478 (15.06)	1278 (13.89)	1971 (15.80)	1825 (14.72)	1752 (12.76)	1460 (14.23)	1875 (13.40)
Concentrate	1920 (24.36)	2450 (24.96)	2600 (28.27)	3400 (27.25)	3360 (27.11)	4800 (34.96)	2475 (24.12)	4500 (32.16)
Labour cost	1369 (17.37)	2053 (20.92)	1900 (20.66)	3044 (24.40)	3696 (29.82)	3422 (24.92)	2500 (24.36)	3422 (24.45)
Medicine and veterinary charges	115 (1.47)	175 (1.78)	145 (1.57)	210 (1.67)	195 (1.57)	330 (2.41)	140 (1.36)	215 (1.54)
Miscellaneous Cost	33.75 (0.43)	44.50 (0.45)	25.60 (0.28)	37.45 (0.30)	45.00 (0.36)	67.20 (0.49)	38.40 (0.37)	67.00 (0.47)
Total Variable Cost	7880.75 (100.00)	9815.50 (100.00)	9198.60 (100.00)	12477.45 (100.00)	12396.00 (100.00)	13729.20 (100.00)	10263.40 (100.00)	13994.00 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE XXXIII

VARIABLE COST PER MILCH ANIMAL PER LACTATION FOR BLOCK II

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Feed cost:								
Green fodder	2336 (27.89)	2628 (28.16)	2792 (26.30)	3103 (26.33)	2792 (25.46)	3103 (24.10)	2555 (23.93)	3504 (29.82)
Dryfodder	1752 (20.91)	1606 (17.21)	1807 (17.02)	1533 (13.01)	1643 (14.98)	1752 (13.60)	1643 (15.39)	1278 (10.87)
Concentrate	1340 (16.00)	2800 (30.00)	3120 (29.39)	3300 (28.01)	3640 (33.19)	4060 (31.53)	3300 (30.91)	3650 (31.06)
Labour cost	2738 (32.68)	2053 (22.00)	2738 (25.79)	3650 (30.98)	2738 (24.97)	3650 (28.35)	3000 (28.11)	3122 (26.57)
Medicine and Veterinary charges	190 (2.27)	215 (2.30)	135 (1.27)	170 (1.44)	110 (1.01)	265 (2.06)	125 (1.17)	150 (1.28)
Miscellaneous Cost	21.10 (0.25)	30.50 (0.33)	24.40 (0.23)	27.00 (0.23)	43.15 (0.39)	47.00 (0.36)	52.15 (0.49)	48.00 (0.40)
Total Variable Cost	8377.10 (100.00)	9332.50 (100.00)	10616.40 (100.00)	11783.00 (100.00)	10966.15 (100.00)	12877.00 (100.00)	10675.15 (100.00)	11752.00 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE XXXIV

VARIABLE COST PER MILCH ANIMAL PER LACTATION FOR BLOCK III

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Feed cost:								
Green fodder	3504 (27.76)	5256 (42.12)	4672 (35.43)	4840 (34.56)	3504 (27.02)	4672 (30.68)	3650 (27.16)	4654 (29.09)
Dryfodder	2190 (17.35)	1460 (11.70)	2628 (19.93)	2555 (18.25)	2044 (15.76)	2555 (16.78)	2628 (19.56)	2190 (13.69)
Concentrate	3120 (24.72)	3480 (27.89)	3600 (27.31)	3640 (26.00)	4125 (31.81)	4320 (28.37)	4200 (31.26)	4800 (30.00)
Labour cost	3650 (28.91)	2053 (16.45)	2053 (15.57)	2738 (19.55)	3106 (23.95)	3422 (22.47)	2790 (20.76)	4106 (25.66)
Medicine and Veterinary charges	105 (0.83)	165 (1.32)	170 (1.29)	165 (1.18)	140 (1.08)	190 (1.25)	105 (0.78)	180 (1.12)
Miscellaneous Cost	54.20 (0.43)	64.70 (0.52)	62.25 (0.47)	65.00 (0.46)	49.00 (0.38)	68.70 (0.45)	64.00 (0.48)	71.10 (0.44)
Total Variable Cost	12623.20 (100.00)	12478.70 (100.00)	13185.25 (100.00)	14003.00 (100.00)	12968.00 (100.00)	15227.70 (100.00)	13437.00 (100.00)	16001.10 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE XXXV

TOTAL COST PER MILCH ANIMAL PER LACTATION FOR BLOCK I

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Total fixed cost	819.65 (9.42)	1152.64 (10.51)	847.23 (8.43)	1960.18 (13.58)	963.84 (7.21)	2256.40 (14.12)	1038.04 (9.19)	2285.81 (14.04)
Total variable cost	7880.75 (90.58)	9815.50 (89.49)	9198.60 (91.57)	12477.45 (86.42)	12396.00 (92.79)	13729.20 (85.88)	10263.40 (90.81)	13994.00 (85.96)
Total cost	8700.40 (100.00)	10968.14 (100.00)	10045.83 (100.00)	14437.63 (100.00)	13359.84 (100.00)	15985.60 (100.00)	11301.44 (100.00)	16279.89 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE XXXVI

TOTAL COST PER MILCH ANIMAL PER LACTATION FOR BLOCK II

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Total fixed cost	739.39 (8.11)	1166.07 (11.11)	856.62 (7.47)	1523.37 (11.45)	898.56 (7.57)	1645.99 (11.33)	966.30 (8.30)	1944.55 (14.20)
Total variable cost	8377.10 (91.89)	9332.50 (88.89)	10616.40 (92.53)	11783.00 (88.55)	10966.15 (92.43)	12877.00 (88.67)	10675.15 (91.70)	11752.00 (85.80)
Total cost	9116.49 (100.00)	10498.57 (100.00)	11473.02 (100.00)	13306.37 (100.00)	11864.71 (100.00)	14522.99 (100.00)	11641.45 (100.00)	13696.55 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE XXXVII

TOTAL COST PER MILCH ANIMAL PER LACTATION FOR BLOCK III

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Total fixed cost	857.30 (6.36)	1476.05 (10.58)	889.40 (6.32)	1828.24 (11.55)	1160.26 (8.21)	2255.57 (12.90)	1258.93 (8.57)	2550.46 (13.75)
Total variable cost	12623.20 (93.64)	12478.70 (89.42)	13185.25 (93.68)	14003.00 (88.45)	12968.00 (91.79)	15227.70 (87.10)	13437.00 (91.43)	16001.10 (86.25)
Total cost	13480.50 (100.00)	13954.75 (100.00)	14074.65 (100.00)	15831.24 (100.00)	14128.26 (100.00)	17483.27 (100.00)	14695.93 (100.00)	18551.56 (100.00)

(Figures in parentheses indicate percentage to total)

Next to feed cost, the cost of labour was found to be in the region of 15 per cent to 32 per cent. Veterinary and miscellaneous charges formed only a paltry share of the maintenance cost in all the milch animals.

The Tables XXXV, XXXVI and XXXVII indicated that the maintenance cost of the cross bred cows was highest as they imbibe higher feed and labour resources in addition to a high investment. The large farmers incurred highest maintenance cost commensurate with their resource endowments and the maintenance cost for buffaloes and cross bred cows had a positive relationship with the size of land holding for all the blocks.

iii. Returns from Milch Animals

The returns in dairy enterprise is a crucial aspect which determines the profitability. Unless the returns are remunerative the landless category and marginal farmers may have to face hardship for their survival through this avocation. Hence it is imperative to have estimates on returns to decide about the potentials of the enterprise under question. The returns are worked out for buffaloe and cross bred cow across different categories of farmers and are presented in Tables XXXVIII, XXXIX and XL.

On a cursory glance one can appreciate that the return was maximum in case of cross bred cows for large farmers followed by small farmers, marginal farmers and landless category for all the blocks. The higher returns from cross breds may solely be attributed to the volume of milk produced. The share of income from milk to the total returns for buffaloes and cross breds was more than 92 percent for all the categories of farmers in all the blocks. The share of empty gunny bags and manure accounted together to the maximum of 6.34 per cent in landless category of block I.

TABLE XXXVIII

RETURNS FROM DIFFERENT SOURCES PER MILCH ANIMAL PER LACTATION FOR BLOCK I

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Sale of milk	12474.00 (93.66)	14355.00 (95.94)	13601.00 (95.83)	16388.00 (95.41)	13125.00 (92.72)	15877.00 (96.22)	12583.00 (95.98)	16800.00 (96.01)
Sale of empty gunny bags	94.00 (0.71)	108.00 (0.72)	117.00 (0.82)	134.00 (0.78)	130.00 (0.92)	148.00 (0.90)	102.00 (0.78)	208.00 (1.19)
Sale of manure	750.00 (5.63)	500.00 (3.34)	475.00 (3.35)	655.00 (3.81)	900.00 (6.36)	475.00 (2.88)	425.00 (3.24)	490.00 (2.80)
Total Return	13318.00 (100.00)	14963.00 (100.00)	14193.00 (100.00)	17177.00 (100.00)	14155.00 (100.00)	16500.00 (100.00)	13110.00 (100.00)	17498.00 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE XXXIX

RETURNS FROM DIFFERENT SOURCES PER MILCH ANIMAL PER LACTATION FOR BLOCK II

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Sale of milk	11715.00 (95.85)	13688.00 (95.82)	12045.00 (95.10)	15921.00 (96.36)	12664.00 (95.78)	16125.00 (97.06)	13686.00 (95.85)	16785.00 (97.03)
Sale of empty gunny bags	132.00 (1.08)	187.00 (1.31)	110.00 (0.87)	187.00 (1.13)	108.00 (0.82)	128.00 (0.77)	118.00 (0.83)	144.00 (0.83)
Sale of manure	375.00 (3.07)	410.00 (2.87)	510.00 (4.03)	415.00 (2.51)	450.00 (3.40)	360.00 (2.17)	475.00 (3.32)	370.00 (2.14)
Total Return	12222.00 (100.00)	14285.00 (100.00)	12665.00 (100.00)	16523.00 (100.00)	13222.00 (100.00)	16613.00 (100.00)	14279.00 (100.00)	17299.00 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE XL

RETURNS FROM DIFFERENT SOURCES PER MILCH ANIMAL PER LACTATION FOR BLOCK III

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Sale of milk	13490.00 (95.82)	16500.00 (96.79)	13950.00 (95.44)	17250.00 (97.22)	13875.00 (96.13)	19400.00 (97.44)	14900.00 (96.69)	20360.00 (97.12)
Sale of empty gunny bags	98.00 (0.70)	148.00 (0.87)	111.00 (0.76)	144.00 (0.81)	98.00 (0.68)	144.00 (0.73)	110.00 (0.71)	178.00 (0.85)
Sale of manure	490.00 (3.48)	400.00 (2.34)	555.00 (3.80)	350.00 (1.97)	460.00 (3.19)	365.00 (1.83)	400.00 (2.60)	425.00 (2.03)
Total Return	14078.00 (100.00)	17048.00 (100.00)	14616.00 (100.00)	17744.00 (100.00)	14433.00 (100.00)	19909.00 (100.00)	15410.00 (100.00)	20963.00 (100.00)

(Figures in parentheses indicate percentage to total)

iv. Net Returns from Milch Animals

The net return is the true measure of the reward for an enterprise. The net returns depends upon the gross returns and the gross cost. The higher the difference between the gross returns and the gross cost the higher is the net returns. The net returns from milch animals can be increased by increasing the production and/or reducing cost of production.

The net return and cost of production per litre of milk for buffaloe and cross bred cow where worked out and are presented in Tables XLI, XLII and XLIII.

The net return was more for buffaloes compared to cross bred cows in all the categories of farmers in block I and the net return was decreased with increase in land holding. The increased net return for buffaloe was due to the pricing policy of higher price for buffaloe milk.

In block II, the highest net income of Rs. 3786.43 was realised in cross bred cows of landless category and the small farmers, marginal farmers and large farmers realised lesser net income. In case of block III, net income from buffaloe milk production was the least and all the categories of farmers received higher income by maintaining cross bred cows and this might be due to the farmers awareness and croppingpattern.

v. Cost of Production of Per Litre of Milk

The cost structure of bovine milk production varies from species to species depending upon the quantity of feed consumed, the rate at which the capital value of a bovine depreciates, the rate of interest which is foregone by investment on the purchase of bovine, the cost of veterinary services etc. rendered to a bovine and cost

TABLE XLI

NET RETURN PER MILCH ANIMAL PER LACTATION AND COST OF PRODUCTION PER LITRE OF MILK FOR BLOCK I

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Total Return	13318.00	14963.00	14193.00	17177.00	14155.00	16500.00	13110.00	17498.00
Total cost	8700.40	10968.14	10045.83	14437.63	13359.84	15985.60	11301.44	16279.89
Net Return	4617.60	3994.86	4147.17	2739.37	795.16	514.40	1808.56	1218.11
Cost of production	6.13	5.72	6.16	5.22	6.14	5.91	6.18	6.17

TABLE XLII

NET RETURN PER MILCH ANIMAL PER LACTATION AND COST OF PRODUCTION PER LITRE OF MILK FOR BLOCK II

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Total Return	12222.00	14285.00	12665.00	16523.00	13222.00	16613.00	14279.00	17299.00
Total cost	9116.49	10498.57	11473.02	13306.37	11864.71	14522.99	11641.45	13696.55
Net Return	3105.51	3786.43	1191.98	3216.63	1357.29	2090.01	2637.55	3602.45
Cost of production	6.12	5.99	6.25	5.54	6.18	5.57	6.15	5.89

TABLE XLIII

NET RETURN PER MILCH ANIMAL PER LACTATION AND COST OF PRODUCTION PER LITRE OF MILK FOR BLOCK III

(In Rs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Total Return	14078.00	17048.00	14616.00	17744.00	14433.00	19909.00	15410.00	20963.00
Total cost	13480.50	13954.75	14074.65	15831.24	14128.26	17483.27	14695.93	18551.56
Net Return	597.50	3093.25	540.35	1912.76	304.74	2425.73	714.07	2411.44
Cost of production	6.27	5.81	6.12	5.90	6.41	5.50	6.62	5.61

on labour. The various components of cost structure also vary from area to area and across seasons in a reference year. Keeping the above in backdrop, the cost of milk production has been estimated for different categories of farmers.

The cost of milk production was less in cross breds compared to buffaloes in all the categories of farmers in all the three blocks. Among different categories of farmers, the per litre cost of production of buffaloe milk was found to be higher (Rs.6.41) in case of small farmer in block III where as in case of cross bred cows the cost of production of milk was lowest (Rs.5.22) among marginal farmer category of block I.

vi. Production and Consumption of Milk

The quantity of milk produced and consumed by the sample farmers holds and the quantity available for sales were worked out and presented in Table XLIV.

It is evident from the table that large farmer category ranks first in milk production, to the tune of 10.202 litres per day per milch animal followed by small farmer, marginal farmer and landless category in that order of the three blocks. The quantity of milk retained for home consumption by different categories of farmers increased with increase in land holdings. The proportion of milk sold declined as land holding increased irrespective of the categories of farmers in all the blocks and the highest proportion was 96.22 per cent in landless category of block I and the lowest proportion was 85.67 per cent in large farmer category of block II.

TABLE XLIV

PRODUCTION, CONSUMPTION AND SALE OF MILK BY SAMPLE FARMERS

(In litres)

Particulars	Block I				Block II				Block III			
	LL	MF	SF	LF	LL	MF	SF	LF	LL	MF	SF	LF
Milk production per household per day	4.907	5.821	6.291	8.975	4.107	5.762	6.101	7.972	4.875	6.212	7.829	10.202
Consumption of milk per day: Milk	0.124	0.156	0.445	1.029	0.101	0.143	0.464	0.917	0.117	0.162	0.472	1.010
Milk products	0.061	0.177	0.372	0.161	0.044	0.154	0.379	0.225	0.078	0.144	0.378	0.184
Total Consumption	0.185	0.333	0.817	1.190	0.145	0.297	0.843	1.142	0.195	0.306	0.850	1.194
Percentage to total production	3.78	5.72	12.99	13.26	3.53	5.15	13.82	14.33	4.00	4.93	10.86	11.70
Sale of milk per household per day	4.722	5.488	5.474	7.785	3.962	5.465	5.258	6.830	4.680	5.906	6.979	9.008
Percentage to total prodution	96.22	94.28	87.01	86.74	96.47	94.85	86.18	85.67	96.00	95.07	89.14	88.30

vii. Mode of Disposal of Milk

The mode of disposal of milk by the sample farmers was tabulated and presented in Table XLV.

On an average 85.50 per cent in block I, 72.88 per cent in block II and 88.29 per cent in block III of different categories of farmers sold milk to milk producers' cooperative societies and the reasons attributed were that procurement price is based on fat content, less frequent price fluctuation, distribution of bonus to the milk producers, supply of feed by the milk societies and free veterinary aid. The share of milk sold to private milk vendors was found to be more in block II and it might be due to lack of knowledge on cooperatives and also advancing loans to the farmers by the vendors.

viii. Input Use in Milk Production

Feed and labour are the important factors of milk production. By reducing these costs, the cost of milk production could be reduced and the net income of farm could be maximised.

Feed : The average feed consumed per milch animal per day was worked out for buffaloe and cross bred cow and are presented in Tables XLVI, XLVII and XLVIII.

The results indicated that the cross bred cows consumed more quantity of green fodder (14.71 kgs.) in block I of marginal farmer category and was found to be lower (8.44 kgs.) in case of marginal farmer category of block II. Dry fodder use was found to be higher in block II irrespective of the categories of farmers and the consumption

TABLE – XLV

MODE OF DISPOSAL OF MILK BY SAMPLE FARMERS

Particulars	Neighbours	Tea shops	Vendors	Co-operative milk society	Total number of farmers
Block I					
LL	–	3 (9.68)	–	28 (90.32)	31 (100.00)
MF	–	2 (6.45)	2 (6.45)	27 (87.10)	31 (100.00)
SF	4 (10.00)	6 (15.00)	–	30 (75.00)	40 (100.00)
LF	2 (6.90)	–	–	27 (93.10)	29 (100.00)
Overall	6 (4.58)	11 (8.40)	2 (1.52)	112 (85.50)	131 (100.00)
Block II					
LL	–	2 (6.25)	6 (18.75)	24 (75.00)	32 (100.00)
MF	2 (7.69)	2 (7.69)	5 (19.24)	17 (65.38)	26 (100.00)
SF	–	–	11 (35.48)	20 (64.52)	31 (100.00)
LF	–	–	4 (13.79)	25 (86.21)	29 (100.00)
Overall	2 (1.69)	4 (3.39)	26 (22.04)	86 (72.88)	118 (100.00)
Block III					
LL	–	3 (11.54)	–	23 (88.46)	26 (100.00)
MF	–	2 (6.67)	2 (6.67)	26 (86.66)	30 (100.00)
SF	–	4 (14.29)	–	24 (85.71)	28 (100.00)
LF	–	–	2 (7.41)	25 (92.59)	27 (100.00)
Overall	–	9 (8.11)	4 (3.60)	98 (88.29)	111 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE XLVI

AVERAGE FEED CONSUMPTION PER MILCH ANIMAL PER DAY FOR BLOCK I

(In Kgs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Green fodder	8.11	14.20	9.22	14.71	7.64	10.21	9.45	11.55
Dry fodder	5.75	5.81	5.90	6.22	6.94	8.70	7.43	8.94
Concentrate	1.22	2.21	1.31	2.98	1.47	3.01	2.10	3.47

TABLE XLVII

AVERAGE FEED CONSUMPTION PER MILCH ANIMAL PER DAY FOR BLOCK II

(In Kgs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Green fodder	6.12	10.12	6.40	8.44	7.51	9.00	6.77	9.22
Dry fodder	9.14	8.15	11.55	12.66	14.22	12.10	12.84	13.00
Concentrate	1.24	2.10	1.33	2.20	1.74	2.98	1.81	3.11

TABLE XLVIII

AVERAGE FEED CONSUMPTION PER MILCH ANIMAL PER DAY FOR BLOCK III

(In Kgs.)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Green fodder	10.12	12.00	9.11	13.00	8.75	14.00	7.65	14.10
Dry fodder	6.22	6.46	5.47	7.42	6.11	6.12	6.74	7.12
Concentrate	1.60	2.40	1.65	3.51	2.57	3.54	2.60	4.22

of concentrates was found to be higher and increased with increase in size of holdings in all the categories of farmers in blocks I, II and III.

The rice bran and tapioca starch waste accounted for the major share of the concentrates in block I and II where as in block III, wheat bran was the major share of the concentrates. Gingelly oil cake and ground nut oil cake were also fed in limited quantities. The major compounded feed used in the study area were the Aavin cattle feed manufactured and marketed by Tamil Nadu Cooperative Milk Producers' Federation. Some farmers prepared their own compounded feed.

Labour : The average use of labour per milch animal per day was worked out and presented in Tables XLIX, L and LI.

The analysis of labour use clearly indicated that the family labour decreased with increase in size of holding and the permanent labour use increased with increase in size of the holding. The use of family labour for tending milch animals in landless and marginal farmers in all the blocks was more as compared to other categories of farmers. Small and large farmers utilised more of hired labour and family labour was mainly used for supervisory work in all the blocks.

There was a clear division of labour with the women performing the various operations in the stalls like cleaning, feeding and milking and the men taking responsibility for purchasing feeds, buying and selling the animals and others.

The average labour use per buffaloe was found to be higher (0.36 man days) in block II of large farmer category and it was found to be low (0.26 man days) in block II of small farmer category. In case of cross bred cow the labour use per milch

TABLE XLIX

LABOUR USE PER MILCH ANIMAL PER DAY BLOCK I

(In man days)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Family labour	0.33 (100.00)	0.42 (100.00)	0.27 (100.00)	0.29 (100.00)	0.24 (72.73)	0.06 (14.29)	0.03 (9.09)	0.05 (10.87)
Permanent labour	-	-	-	-	0.09 (27.27)	0.36 (85.71)	0.30 (90.91)	0.41 (89.13)
Total labour	0.33 (100.00)	0.42 (100.00)	0.27 (100.00)	0.29 (100.00)	0.33 (100.00)	0.42 (100.00)	0.33 (100.00)	0.46 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE L

LABOUR USE PER MILCH ANIMAL PER DAY BLOCK II

(In man days)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Family labour	0.34 (100.00)	0.41 (100.00)	0.29 (100.00)	0.33 (100.00)	0.26 (100.00)	0.10 (31.25)	0.05 ((13.89)	0.08 (17.02)
Permanent labour	–	–	–	–	–	0.22 (68.75)	0.31 (86.11)	0.39 (82.98)
Total labour	0.34 (100.00)	0.41 (100.00)	0.29 (100.00)	0.33 (100.00)	0.26 (100.00)	0.32 (100.00)	0.36 (100.00)	0.47 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE LI

LABOUR USE PER MILCH ANIMAL PER DAY BLOCK III

(In man days)

Particulars	LL		MF		SF		LF	
	B	CB	B	CB	B	CB	B	CB
Family labour	0.37 (100.00)	0.44 (100.00)	0.29 (100.00)	0.33 (94.29)	0.26 (76.47)	0.07 (17.50)	0.04 (11.43)	0.02 (4.35)
Permanent labour	-	-	-	0.02 (5.71)	0.08 (23.53)	0.33 (82.50)	0.31 (88.57)	0.44 (95.65)
Total labour	0.37 (100.00)	0.44 (100.00)	0.29 (100.00)	0.35 (100.00)	0.34 (100.00)	0.40 (100.00)	0.35 (100.00)	0.46 (100.00)

(Figures in parentheses indicate percentage to total)

animal was found to be more (0.47 man days) in block II of large farmer and it was found to be low (0.29 man days) in block I of marginal farmer category. In general the labour use was found to be more in case of cross breds irrespective of the holdings for all the blocks.

ix. Economics of Crop Enterprise

The profit of any enterprise is ascertained by the cost incurred in running the enterprise and its relationship with the returns accruing with the same enterprise. Therefore, the same is applicable to crop enterprise as well. The results of the costs, returns and profits for the various crops grown in the sample farms are discussed below.

Costs: The details on the cost of cultivation of different crops cultivated in the sample farms in each of the three blocks under different categories of farmers were collected and analysed. The results are presented in Table LII, LIII and LIV.

In block I, the crops like tapioca, sugarcane, paddy, groundnut and cotton are cultivated. Among the crops grown, sugarcane had the maximum cost of cultivation followed by cotton, tapioca, paddy and groundnut for all the categories of farmers. While, observing the cost of cultivation of all the crops, expenditure on human and machine labour formed the major share followed by fertilizers and manures and plant protection chemicals.

It was found that the share of plant protection chemicals and cost of fertilizers and manures were high incase of cotton and sugarcane respectively for all the categories of farmers. Generally, it was found that the expenditure incurred by hiring human

TABLE LII

AVERAGE COST OF CULTIVATION (TOTAL VARIABLE COST ONLY) OF MAJOR CROPS CULTIVATED IN BLOCK I

(Rs./acre)

Crops	Category of farmers	Machine labour	Human labour	Seeds	Fertilizers and manures	Plant protection chemicals	Others	Interest on working capital	Total cost
Tapioca	MF	788.91 (16.66)	1487.60 (31.41)	175.25 (3.70)	1350.60 (28.52)	250.41 (5.29)	101.24 (2.14)	581.56 (12.28)	4735.57 (100.00)
	SF	990.44 (24.13)	945.50 (23.04)	180.33 (4.39)	1275.41 (31.08)	110.10 (2.68)	98.55 (2.40)	504.05 (12.28)	4104.38 (100.00)
	LF	550.60 (12.25)	1475.50 (32.82)	178.12 (3.96)	1410.15 (31.36)	175.20 (3.90)	154.32 (3.43)	552.14 (12.28)	4496.03 (100.00)
Sugarcane	MF	1450.10 (20.73)	1900.00 (27.16)	1210.65 (17.30)	1501.66 (21.46)	150.44 (2.15)	102.42 (1.46)	681.12 (9.74)	6996.39 (100.00)
	SF	1365.75 (15.98)	1895.15 (22.17)	1350.40 (15.80)	2400.74 (28.09)	175.10 (2.05)	310.11 (3.63)	1049.62 (12.28)	8546.87 (100.00)
	LF	1650.80 (17.26)	2050.45 (21.44)	1390.15 (14.54)	2750.66 (28.76)	201.45 (2.11)	345.15 (3.61)	1174.41 (12.28)	9563.07 (100.00)
Paddy	MF	956.47 (36.08)	275.55 (10.46)	246.64 (9.36)	650.11 (24.68)	347.11 (13.19)	75.14 (2.85)	89.07 (3.38)	2634.09 (100.00)
	SF	1150.33 (35.61)	360.40 (11.16)	215.10 (6.66)	950.42 (29.43)	365.12 (11.30)	79.41 (2.46)	109.23 (3.38)	3230.01 (100.00)
	LF	1175.42 (32.91)	460.50 (12.89)	239.47 (6.70)	1014.90 (28.41)	475.11 (13.30)	85.99 (2.41)	120.80 (3.38)	3572.19 (100.00)
Groundnut	MF	454.11 (17.82)	515.74 (20.24)	900.15 (35.32)	455.17 (17.86)	95.00 (3.73)	42.15 (1.65)	86.18 (3.38)	2548.50 (100.00)
	SF	275.12 (10.41)	750.91 (28.40)	810.27 (30.65)	575.42 (21.77)	85.18 (3.22)	57.33 (2.17)	89.40 (3.38)	2643.63 (100.00)
	LF	645.10 (18.39)	775.41 (22.11)	880.14 (25.10)	850.15 (24.24)	175.21 (5.00)	62.55 (1.78)	118.60 (3.38)	3507.16 (100.00)
Cotton	MF	475.11 (12.36)	1050.95 (27.33)	104.10 (2.71)	345.77 (8.99)	1550.14 (40.32)	67.44 (1.75)	251.55 (6.54)	3845.06 (100.00)
	SF	404.15 (8.94)	1375.00 (30.43)	106.14 (2.35)	475.44 (10.52)	1775.75 (39.29)	87.12 (1.93)	295.65 (6.54)	4519.25 (100.00)
	LF	510.20 (10.32)	1410.16 (28.52)	105.11 (2.13)	510.11 (10.32)	1890.15 (38.23)	195.11 (3.95)	323.46 (6.54)	4944.30 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE LIII

AVERAGE COST OF CULTIVATION (TOTAL VARIABLE COST ONLY) OF MAJOR CROPS CULTIVATED IN BLOCK II

(Rs./acre)

Crops	Category of farmers	Machine labour	Human labour	Seeds	Fertilizers and manures	Plant protection chemicals	others	Interest on working capital	Total cost
Tapioca	MF	615.12 (16.73)	1350.11 (36.71)	160.44 (4.36)	950.12 (25.84)	95.00 (2.58)	55.14 (1.50)	451.63 (12.28)	3677.56 (100.00)
	SF	655.17 (17.04)	1210.41 (31.48)	175.23 (4.55)	1150.11 (29.91)	108.10 (2.81)	74.33 (1.93)	472.27 (12.28)	3845.62 (100.00)
	LF	778.15 (17.94)	1395.22 (32.17)	164.47 (3.79)	1275.42 (29.40)	147.19 (3.39)	44.44 (1.03)	532.68 (12.28)	4337.57 (100.00)
Sugarcane	MF	1100.22 (18.16)	1650.12 (27.24)	1050.11 (17.34)	1350.41 (22.30)	101.40 (1.67)	60.84 (1.01)	743.83 (12.28)	6056.93 (100.00)
	SF	1175.21 (15.81)	1710.14 (23.00)	1375.51 (18.50)	1975.22 (26.57)	175.45 (2.36)	110.11 (1.48)	913.03 (12.28)	7434.67 (100.00)
	LF	1280.41 (15.97)	1875.94 (23.39)	1390.44 (17.34)	2175.41 (27.13)	204.11 (2.54)	108.49 (1.35)	984.87 (12.28)	8019.67 (100.00)
Paddy	MF	415.11 (20.65)	475.55 (23.66)	220.22 (10.96)	575.11 (28.61)	115.10 (5.73)	141.14 (7.01)	67.98 (3.38)	2010.21 (100.00)
	SF	675.42 (24.62)	510.11 (18.59)	247.15 (9.01)	875.41 (31.91)	197.48 (7.20)	145.15 (5.29)	92.78 (3.38)	2743.50 (100.00)
	LF	690.55 (23.57)	545.44 (18.62)	235.44 (8.04)	910.11 (31.07)	280.55 (9.58)	168.19 (5.74)	99.06 (3.38)	2929.34 (100.00)
Groundnut	MF	345.12 (15.17)	610.11 (26.81)	775.00 (34.05)	375.11 (16.48)	60.15 (2.64)	33.45 (1.47)	76.96 (3.38)	2275.90 (100.00)
	SF	300.40 (11.25)	750.12 (28.10)	890.14 (33.35)	450.16 (16.86)	110.11 (4.13)	78.15 (2.93)	90.27 (3.38)	2669.35 (100.00)
	LF	375.44 (13.34)	660.14 (23.45)	915.14 (32.50)	575.12 (20.43)	114.12 (4.05)	80.16 (2.85)	95.20 (3.38)	2815.32 (100.00)
Cotton	MF	275.00 (9.19)	975.11 (32.58)	110.61 (3.69)	271.14 (9.06)	1090.45 (36.43)	75.16 (2.51)	195.82 (6.54)	2993.29 (100.00)
	SF	350.65 (10.11)	1150.22 (33.18)	108.44 (3.13)	310.42 (8.96)	1210.11 (34.90)	110.41 ((3.18)	226.82 (6.54)	3467.07 (100.00)
	LF	425.11 (10.43)	1315.41 (32.26)	112.11 (2.75)	415.17 (10.18)	1395.42 (34.22)	147.71 (3.62)	266.77 (6.54)	4077.70 (100.00)

(Figures in parentheses indicate percentage to total)

TABLE LIV

AVERAGE COST OF CULTIVATION (TOTAL VARIABLE COST ONLY) OF MAJOR CROPS CULTIVATED IN BLOCK III

(Rs./acre)

Crops	Category of farmers	Machine labour	Human labour	Seeds	Fertilizers and manures	Plant protection chemicals	Others	Interest on working capital	Total cost
Paddy	MF	775.45 (26.50)	340.10 (11.63)	262.67 (8.98)	975.42 (33.34)	375.15 (12.82)	98.10 (3.35)	98.94 (3.38)	2925.83 (100.00)
	SF	847.44 (28.80)	241.37 (8.20)	251.55 (8.55)	1050.22 (35.69)	342.77 (11.65)	109.71 (3.73)	99.51 (3.38)	2942.57 (100.00)
	LF	865.54 (27.08)	365.33 (11.43)	267.42 (8.37)	1097.11 (34.33)	382.11 (11.96)	110.11 (3.45)	108.07 (3.38)	3195.69 (100.00)
Groundnut	MF	215.47 (10.79)	475.55 (23.80)	815.00 (40.79)	225.21 (11.27)	125.11 (6.26)	74.21 (3.71)	67.57 (3.38)	1998.12 (100.00)
	SF	275.23 (11.70)	510.14 (21.68)	875.15 (37.19)	327.28 (13.91)	175.41 (7.45)	110.41 (4.69)	79.58 (3.38)	2353.20 (100.00)
	LF	410.31 (14.18)	675.35 (23.35)	905.41 (31.30)	431.44 (14.92)	210.14 (7.26)	162.33 (5.61)	97.82 (3.38)	2892.80 (100.00)
Sugarcane	MF	1050.10 (16.27)	1375.10 (21.30)	950.41 (14.73)	2110.11 (32.70)	110.42 (1.71)	65.15 (1.01)	792.58 (12.28)	6453.87 (100.00)
	SF	1175.42 (15.07)	1541.71 (19.77)	1100.66 (14.12)	2780.21 (35.66)	147.77 (1.90)	93.33 (1.20)	957.47 (12.28)	7796.57 (100.00)
	LF	1250.33 (14.70)	1497.88 (17.61)	1230.34 (14.46)	3210.43 (37.74)	175.42 (2.06)	97.41 (1.15)	1044.65 (12.28)	8506.46 (100.00)

(Figures in parentheses indicate percentage to total)

labour was higher in large farms when compared to small and medium farms. This might be due to efficient utilisation of family labour in small and medium farms.

In block II, it could be discussed from Table XXXVII that the cost of cultivation per acre was the maximum in sugarcane and it worked out to Rs.6056.93, Rs.7434.67 and Rs.8019.67 for marginal farmers, small farmers and large farmers respectively where as cost of cultivation of tapioca found to be Rs.3677.56, Rs.3845.62 and Rs.4337.57 for marginal, small and large farmers respectively. The expenditure on labour (machine labour and human labour) formed the major share followed by fertilizers and manures and plant protection chemicals.

The details on the cost of cultivation of crops raised in block III indicated that unlike in other two blocks, only paddy, groundnut and sugarcane are cultivated in this area. The major crop of this block is paddy and only limited area is under groundnut andsugarcane. This might be due to the size of holding as well as the availability of canal irrigation. The cost of cultivation of paddy per acre was found to be Rs.2925.83, Rs.2942.57 and Rs.3195.69 for marginal, small and large farmers respectively.

Returns : In the farm enterprise, yield of crops and prices realised for them determine the gross returns and less of cost of cultivation would show the net returns. Income realised from different crops raised in the sample farms will help in comparing the profitability and efficiency in utilising the farm resources in different size groups. The gross and net income realised from crops in different categories of farmers in all the three block are presented in Tables LV, LVI and LVII.

It could be observed in block I that sugarcane realised the maximum net income followed by cotton, ground nut, tapioca and paddy in all the categories of farmers

TABLE LV
NET RETURN REALISED FROM DIFFERENT CROPS FOR BLOCK I

(Rs. / acre)

Crops	MF			SF			LF		
	Total cost	Total Return	Net Return	Total cost	Total Return	Net Return	Total cost	Total Return	Net Return
Tapioca	4735.57	7200.00	2644.43	4104.38	8370.00	4265.62	4496.03	8372.00	3875.57
Sugarcane	6996.39	17806.00	10809.61	8546.87	21490.00	12943.13	9563.07	20876.00	11312.93
Paddy	2634.09	4950.00	2315.91	3230.01	6300.00	3069.99	3572.19	6460.00	2887.81
Groundnut	2548.50	7680.00	5131.50	2643.63	7150.00	4506.37	3507.16	7245.00	3737.84
Cotton	3845.06	10500.00	6654.94	4519.25	13300.00	8780.75	4944.30	14812.50	9868.20

TABLE LVI
NET RETURN REALISED FROM DIFFERENT CROPS FOR BLOCK II

(Rs. / acre)

Crops	MF			SF			LF		
	Total cost	Total Return	Net Return	Total cost	Total Return	Net Return	Total cost	Total Return	Net Return
Tapioca	3677.56	8100.00	4422.44	3845.62	7225.00	3379.38	4337.57	8265.00	3927.43
Sugarcane	6056.93	16108.00	9943.07	7434.67	19840.00	12405.33	8019.67	20480.00	12460.33
Paddy	2010.21	5580.00	3569.79	2743.50	6300.00	3556.50	2929.34	6500.00	3570.66
Groundnut	2275.90	8125.00	5849.10	2669.35	7260.00	4590.65	2815.32	8840.00	6024.68
Cotton	2993.29	11340.00	8346.71	3467.07	13300.00	9832.93	4077.70	14600.00	10522.30

TABLE LVII
NET RETURN REALISED FROM DIFFERENT CROPS FOR BLOCK III

(Rs./acre)

Crops	MF			SF			LF		
	Total cost	Total Return	Net Return	Total cost	Total Return	Net Return	Total cost	Total Return	Net Return
Paddy	2925.83	6080.00	3154.17	2942.57	6800.00	3857.43	3195.69	7055.00	3859.57
Groundnut	1998.12	7040.00	5041.88	2353.20	7475.00	5121.80	2892.80	7920.00	5027.20
Sugarcane	6453.87	17080.00	10626.13	7796.57	20480.00	12683.43	8506.46	22400.00	13893.54

and the net income was found to be more in small farmer category for all the crops. The net income realised from paddy was found to be less irrespective of the category of farmers.

In block II, the net income realised per acre from tapioca, sugarcane and cotton were found to be increased as the size of holding increased where as the net income realised from paddy was about Rs.3550 per acre for all the categories of farmers. The maximum net income was realised from sugarcane to the tune of Rs.12460.33 per acre in large farmers.

In block III, only paddy, groundnut and sugarcane are cultivated and the net income per acre was found to be increased as the size of holding increased and the maximum net income was realised from sugarcane followed by groundnut and paddy.

3. RESOURCE PRODUCTIVITY IN DAIRYING

The resource or input factor is important to be used most efficiently if it marginal value product is just sufficient to offset its cost. To study the efficiency in the use of inputs in the sample farms, Cobb-Douglas form of production function was specified and estimated. the use of sample average price eliminated the problem of inter farm variation income or expenditure due to prices.

Block I

The estimated parameters of SFPF by MLE and COLS methods and average production function for landless marginal small and large farmers of Block-I (Pappireddipatty) are presented in Table LVIII. All the estimated coefficient of multiple determination is being greater than 0.69 and statistically significant showed a good fit. The elasticity coefficient of concentrate is statistically significant at 5 per

TABLE LVIII

ESTIMATED COEFFICIENTS OF THE AVERAGE PRODUCTION AND STOCHASTIC FRONTIER PRODUCTION FUNCTION FOR BLOCK I

Variables	Categories of farmers	Landless		Marginal Farmer		Small Farmer		Large Farmer	
	Model	OLS	MLE	OLS	MLE	OLS	MLE	OLS	MLE
Intercept		145.7132 (−0.6796)	271.3200 (−0.7123)	55.7312* (4.9628)	61.8213* (4.8131)	2.8602 (0.5550)	3.9128 (0.7928)	1.9169 (0.2592)	2.3412 (0.3124)
Green fodder (in Rs.) (X1)		0.2680 (1.4900)	0.2813 (−1.5791)	0.8547* (12.4065)	0.8651* (12.3017)	0.0734 (0.7629)	0.0943 (0.8132)	0.2124 (0.8081)	0.2213 (0.8319)
Dry fodder (in Rs.) (X2)		0.1300 (0.6761)	0.1509 (0.6910)	−0.1677 (−0.3570)	−0.1607 (−0.3570)	0.3072 (2.1188)	0.3172* (2.341)	0.1196 (0.6733)	0.1203 (0.6818)
Concentrate (in Rs.) (X3)		0.4646* (3.1705)	0.4674* (3.1901)	−0.11486* (−2.3426)	−0.1128* (−2.3426)	0.1243 (1.6499)	0.1343 (1.781)	0.4728* (2.0798)	0.4818* (2.1791)
Labour (in Rs.) (X4)		0.0851 (0.5925)	0.0851 (0.7012)	0.01723 (0.0353)	0.0202 (3.5901)	0.3154 (1.1749)	0.3158* (1.9810)	0.1283 (0.5561)	0.1304 (0.0781)
Cost on Health care (in Rs.) (X5)		0.2921* (3.4989)	0.3121* (3.6981)	0.0358 (0.0764)	0.0471 (0.0757)	−0.0280 (−0.0297)	−0.0280 (−0.0312)	0.0149 (0.1759)	0.0191 (0.1819)
Herd size (in numbers) (X6)		−0.1222 (−0.9154)	−0.1191 (−0.9154)	−0.1122 (0.5059)	−0.0912 (−0.5192)	0.1448 (1.3241)	0.1614 (1.6241)	0.2758* (2.7230)	0.2799* (2.9121)
Dummy (0 for Buffalo and 1 for cross bred cow)		0.1464 (1.0421)	0.1768* (1.9123)	−0.0015 (−0.0047)	−1.3019 (−0.0232)	0.1664* (2.8317)	0.1861* (3.1020)	0.2096 (1.7561)	0.2182 (1.8120)
R^2		0.8599	0.8412	0.9498	0.9561	0.6906	0.7129	0.7214	0.7310
F		21.92*	23.142*	73.02*	75.01*	8.61*	9.31*	7.1879*	7.9121*
ϑ(Relative variability)			0.7901*		0.7121*		0.7312*		0.6792*
Return to Scale		1.12*	1.18*	0.52	0.57	0.94	1.00	1.22*	1.25*

Figures in parentheses indicate percentage to total
* Significant at five per cent level

NOTE :

Categories of farmers	Intercept(COLSestimate)	Percent higher than that of OLS estimate	σ^2_{ui}
LL	234.3068	60.80	1.731
MF	60.1312	7.89	1.412
SF	3.1201	9.09	1.813
LF	2.2231	15.91	1.312

cent level in the estimated functions for the landless category, marginal farmers and large farmers where as it is non-significant among small farmers. The negative significant elasticity coefficient of the concentrate among marginal farmers revealed its excess use which needs to be reduced.

The coefficient of cost of healthcare is significant among landless category only. This is because of better management practices followed by them as this is the only source of income for the landless. The negative non-significant elasticity coefficient on cost on health care among small farmers indicated the excessive amount spent on health care. The dummy variable among landless and small farmer were significant indicated that the milk yield could be increased through rearing cross bred cow.

The elasticity coefficient of the herds size is significant only among large farmers indicating their ability to invest more on milch animals and also because of economics of the scale. The estimated elasticity coefficient of labour in the stochastic frontier production function of small farmer is significant (and this is because of optimal use of labour in this category). The negative non significant elasticity coefficient associated dry fodder for marginal farmer indicated its excessive use.

All the estimated coefficients in all the functions among the categories of farmer were numerically less than unity indicating that their use was in the economically rational region of production and they significantly contribute to milk production. Compared to OLS estimates, stochastic frontier production functions had larger numerical values for all the coefficient associated with inputs. Hence, these variable would improve technical efficiency of the farms. Comparison of OLS estimate with that of the stochastic frontier production function revealed that the best practiced production function did not shift neutrally from the average production function. This result is reasonable because of the better feeding, breeding and health care practices followed by the farmers.

The t test revealed that there exist decreasing return to scale in marginal farmers and increasing return to scale for large farmers. The t test indicated that existence constant return to scale in LL and SF though the sum of the production elasticities ($\Sigma\beta_i$) ranged from 1.12 to 1.18 for landless and .94 to 1.00 for SF. The estimated more than unity value of return to scale though statistically not different from one, indicated that this might be due to the fact that the excluded factor inputs varied more proportionately with changes in the included factors over the sample of observations and the reverse situation holds true the elasticity of production or return to scale will be under estimated.(Heady and Dillon, 1961).

The intercept term of stochastic frontier production (COLS estimates) for all the categories of farms being greater than 8 per cent than that of the OLS estimate of the function and this indicated that the best practiced production function had shifted neutrally (Hicks neutral) from the average production function. Meeuson and Broeck (1977) and Battese and Corra (1977) obtained similar neutral shifts. However, this neutral shift could be because of the techniques selected to estimate the stochastic frontier production function. This strongly suggested that atleast some of the sample farmers were adopting the best dairy production.

The parameter r in the density function differed from λ used by Aigner and Schmidt (1977). The advantage of using r is that it varies from 0 to 1 while λ

varies from 0-∞. The estimate r (u_i and v_i) were significant at 5 per cent level. This revealed that the deviation in the milk mostly by farmers failure to adopt the modern managementpractices.

In all the categories of farms $\sigma\ u_i^2$ being greater than one (different from zero) implied that the symmetric error v_i is not the predominant error. The milk yield differed from maximum possible yield mainly because of the factors under control i.e., inappropriate allocation of inputs.

Block II

The estimated parameters of SRPF by MLE and COLS and average production function for landless, marginal, small and large farmers are presented in Table LIX.

The significant coefficient of multiple determination of all the functions for all the categories of farmers indicate a good fit. The elasticity coefficient of concentrate is statistically significant in the estimated functions of landless category, marginal farmers and small farmers. Thus the contribution of concentrate to milk yield is significant.

The non significant negative elasticity coefficient on health care in landless, small farmers and large farmers.

The significant elasticity coefficient of hard size in large farmer had an unexpected negative sign revealed the existence of excel number of milch animals, resulted in reduction of milk yield. This is because of inadequate supply of inputs viz., green fodder, dry fodder and concentrate. Since the major crop of this block is sugarcane.

ESTIMATED COEFFICIENTS OF THE AVERAGE PRODUCTION AND STOCHASTIC FRONTIER PRODUCTION FUNCTION FOR BLOCK II

Variables	Categories of farmers	Land Less		Marginal Farmer		Small Farmer		Large Farmer	
	model	OLS	MLE	OLS	MLE	OLS	MLE	OLS	MLE
ercept		603.3304* (2.8605)	703.492* (3.8901)	57.0713 (0.4202)	68.1013 (0.8121)	1.5035 (0.0834)	2.0132 (0.1092)	0.0427 (–0.4925)	0.1027 (–0.6912)
een fodder (in Rs.) (X1)		–0.0864 (–0.5155)	–0.08791 (–0.6123)	2.4347* (3.1191)	2.1327* (3.017)	0.4727 (1.5138)	0.4791 (1.8123)	0.7922 (1.7760)	0.8122 (1.8760)
y fodder (in Rs.) (X2)		–0.1823 (–1.9577)	–0.1713 (–1.8912)	–2.5610* (–4.3863)	–2.431* (–3.3912)	0.0501 (–0.2845)	0.0591 (–0.2913)	0.4790 (1.3804)	0.4912 (1.4012)
ncentrate (in Rs.) (X3)		0.5142* (3.6885)	0.5423* (3.3461)	1.9393* (3.6197)	1.9491* (3.7121)	0.5013* (2.048)	0.5103* (2.134)	0.6790 (1.2807)	0.6990 (1.2807)
oour (in Rs.) (X4)		–0.1163 (–1.7453)	–0.1173 (–1.7421)	–0.6632 (–0.8063)	–0.6510 (–0.8912)	0.0161 (0.0608)	0.0171 (0.0710)	–0.3583 (–0.7481)	–0.3585 (–0.7841)
st on Health Care (in Rs.) (X5)		–0.0498 (–0.5660)	–0.0310 (–0.6191)	0.1751 (0.4088)	0.1891 (0.5188)	–0.0750 (–0.7105)	–0.0609 (–0.7912)	–0.3385 (–1.0865)	–0.3085 (–1.0927)
rd size (in numbers) (X6)		–0.0477 (–0.7886)	–0.0313 (–0.7903)	–0.5395 (–1.8401)	–0.5195 (–1.9012)	–0.0199 (–0.1700)	–0.0201 (–0.1751)	–0.8261* (–2.9216)	–0.7219* (–2.812)
mmy (0 for Buffalo and 1 for Cross bred v)		0.3777* (3.5387)	0.4131* (–3.9123)	–0.3540 (–0.7768)	–0.3012 (–0.7810)	0.2078 (1.665)	0.2129 (1.671)	1.2013* (4.1521)	1.301* (4.927)
		0.7835	0.7912	0.9736	0.9801	0.4078	0.4312	0.6026*	0.6312*
		13.962*	14.23*	116.2026*	118.2071*	3.755*	3.851*	5.63*	6.792*
Relative variability)			0.3121*		0.7121*		0.6912*		0.1712
turn to Scale		0.10317	0.10349	0.79	1.07	0.95	0.98	0.43	0.61

ures in parentheses indicate percentage to total
gnificant at five per cent level

NOTE :

Categories of farmers	Intercept(COLSestimate)	Percent higher than that of OLS estimate	σ^2_{ui}
LL	673.3386	11.60	0.0550
MF	63.0989	20.56	1.6122
SF	1.8960	26.11	1.9012
LF	0.0913	66.98	0.0452

The significant unexpected negative sign for the coefficient of dry fodder and ignificant expected positive sign of green fodder for marginal farmers indicated the necessity of reallocation of various inputs to maximise the milk yield. All the estimated elasticity coefficient in all the functions in all the categories of farmers (except green and dry fodder in marginal farmer) were numerically less than unity revealed that these resources operating in the economically rational region of production and contributed significantly to the milk production.

The MLE estimates of SFPF in numerical values were greater than that of the OLS estimated associated with respective inputs. Hence these variable may likely to improve the technical efficiently of the farm and also the best practiced production function did not shift.

The t test indicated that the existence of constant return to scale in marginal farms and small farms with numerical values slightly less than unity. This might be due to the fact that the excluded factor inputs varied less proportionately with changes in the included factor input over the sample of observations.

The intercept term in SFPF (COLs estimate) for all categories of farm being greater from 11 per cent than that of the OLS estimate function revealed that the shift is neutral from the average production function. This might be due to the fact, eliminating the bias in the intercept term of the OLS estimate. This strongly suggested that atleast some of the sample farmers were adopting the best production practices

The estimate of the relative variability were significant of 5 per cent level for landless, marginal and small farmers indicated the farmers failure to adopt the latest feeding, breeding health care practices. The relative variability coefficient is non-significant and σu_i^2 is very close to zero which implied that symmetric error v_i in the error and then r is tending to zero. This means that the milk yield in these categories differed from maximum feasible yield mainly because of external factors.

Block III

The estimated parameters as average production function and SF PF for all the categories of farmers in block III are presented in Table LX. All the functions had statistically significant value of R^2 showed the goodness of fit. Significant elasticity coefficient was obtained for concentrate in landless, small farmers and large farmers. The significant coefficient attached to dummy variable except in large farmer indicated the contribution of cross bred to the milk yield. The coefficient of cost on healthcare contributes significantly revealed its role on milk yield in marginal farmers.

The negative non significant elasticity coefficients of labour in land less and marginal farmers implied excessive use of human labour in the maintenance of milch animals. All the estimated coefficients were numerically less than unity indications that there use was in the economically rational region of production.

Comparing to OLS estimate the SF PF had a larger numerical values for all the coefficients associated with the inputs. Hence these variables would improve technical efficiency of dairy farms.

Comparison of OLS estimate with that of the SF PF revealed the best practiced production function did not best shift neutrally from the average production function. This result is reasonable to accept because of the adoption of the best management practices in the farms.

ESTIMATED COEFFICIENTS OF THE AVERAGE PRODUCTION AND STOCHASTIC FRONTIER PRODUCTION FUNCTION FOR BLOCK III

Variable / Categories of Farmer	Land less		Marginal Farmer		Small Farmer		Large Farmer	
Model	OLS	MLE	OLS	MLE	OLS	MLE	OLS	MLE
Intercept	132.7912 (1.3714)	152.8213 (1.4912)	87.3768 (2.169)	113.4291* (2.314)	2.4157 (0.6766)	3.3978 (0,7912)	77.4242 (1.3346)	115.4923 (1.7819)
Green fodder (in Rs.) (X1)	–0.1155 (–0.2344)	–0.1011 (–0.5012)	0.2154 (1.2810)	0.2198 (1.3109)	–0.0857 (–0.4616)	–0.0719 (–0.4723)	–0.2330 (–0.7967)	–0.2130 (–0.8012)
Dry fodder (in Rs.) (X2)	–0.2344 (–1.4452)	–0.2044 (–1.3412)	0.0879 (0.6269)	0.0910 (0.6392)	0.04526 (0.3809)	0.0551 (0.3993)	0.1245 (–0.8381)	0.1285 (0.8591)
Concentrate (in Rs.) (X3)	0.6791* (2.9184)	0.6810* (2.8131)	0.04908 (0.3563)	0.0510 (0.3589)	0.3344* (2.3905)	0.3581* (2.4910)	0.4607* (2.2506)	0.4701* (2.2701),
Labour (in Rs.) (X4)	–0.04506 (–0.4088)	–0.03102 (–0.5088)	–0.1147 (–1.1940)	–0.1047 (–1.1891)	0.02629 (0.2139)	0.0316 (0.2291)	0.1710 (1.4156)	0.1750 (1.6151)
Cost on Health Care (in Rs.) (X5)	–0.00029 (–0.001831)	–0.0031 (–0.0011)	0.2410* (2.6062)	0.2495* (2.6079)	0.0575 (0.6727)	0.0675 (0.6712)	–0.1688 (–1.4480)	–0.1608 (1.4910)
Herd size (in number) (X6)	–0.0988 (–1.1239)	–0.1021 (–1.1492)	0.09200 (0.9226)	0.0940 (0.9331)	0.0655 (0.6741)	0.0711 (0.6712)	0.1510 (1.6066)	0.1598 (1.7010)
Dummy (0 for Buffalo and 1 for Cross bred cow)	0.3759* (2.3390)	0.3812* (2.4912)	0.4238* (3.7143)	0.4310* (3.7234)	0.5143* (4.244)	0.05141* (4.312)	0.2455 (1.9394)	0.2510 (2.013)
R^2	0.7642	0.7762	0.5612	0.5912	0.8819	0.8910	0.7163	0.7197
F	7.4061*	8.401*	4.568	5.127	23.4906	25.412	3.4249	3.721
ϑ (Relative variability)		0.4123		0.8123*		0.3231*		0.7912*
Return to scale	0.19	0.24	0.57	0.60	0.44	0.51	0.51	0.56

Figures in parentheses indicate percentage to total
* Significant at five per cent level

NOTE :

Categories of farmers	Intercept(COLSestimate)	Percent higher than that of OLS estimate	σ^2_{ui}
LL	147.12	10.79	0.0931
MF	109.4201	25.29	1.7213
SF	2.9321	51.64	0.1482
LF	91.7913	18.56	1.4131

The sum of the production elasticities ranged from 0.19 to 0.06 indicated the existence of decreasing return to scale in all categories of farmers.

The intercept term of SF PF estimated by OLS being greater than 11 per cent higher than that of the OLS estimate proved the best practiced production function had shifted neutrally from the average production function. The estimate ϑ were 0.8123 for marginal farmers and 0.7912 for large farmers and statistically significant implying that the variation of milk yield from maximum feasible yield were mainly due to the difference in the use of best practices of production. In these categories of farms the symmetric error term v_i is not the predominant error. The milk yield differed from maximum yield mainly because of factors under control. The productivity differences were related to the farmers lack in the adoption of better management practices.

The relative variability coefficient ϑ were non significant and $\sigma^2 u$ is very close to zero which implied the symmetric error is the predominant error. It means the milk yield in these farms from the maximum yield, because of either the external factors not under control or the statical errors.

Technical Efficiency

The farmers in this study area operated in the rational region of production function as discussed earlier. Some of the farmers were able to exploit the potentials fully and maximizes the output. This might be due to the choice and proper allocation of inputs technically.

The failure of most of the farmers to maximise the output inspite of operations in the rational region of production might be due to non adoption of management

TABLE LXI

FREQUENCY DISTRIBUTION OF TECHNICAL EFFICIENCY OF VARIOUS CATEGORY OF FARMERS IN BLOCK I

Frequency	Landless labour		Marginal farmers		Small farmers		Large farmers	
	Buffaloe	Cross bred cow	Buffaloe	Cross bred cow	Buffaloe	Cross bred cow	Buffaloe	Cross bred cow
0.10 – 0.20	1 (5.26)	–	–	–	–	–	–	–
0.21 – 0.30	6 (31.58)	–	3 (30.00)	2 (10.00)	1 (12.50)	–	1 (12.50)	2 (10.53)
0.31 – 0.40	9 (47.37)	2 (28.57)	5. (50.00)	5 (25.00)	4 (50.00)	2 (10.00)	3 (37.50)	2 (10.53)
0.41 – 0.50	3 (15.79)	4 (57.14)	2 (20.00)	8 (40.00)	2 (25.00)	6 (30.00)	3 (37.50)	3 (15.79)
0.51 – 0.60	–	1 (14.29)	–	3 (15.00)	1 (12.50)	6 (30.00)	1 (12.50)	5 (26.32)
0.61 – 0.70	–	–	–	2 (10.00)	–	4 (20.00)	–	4 (21.04)
0.71 – 0.80	–	–	–	–	–	2 (10.00)	–	3 (15.79)
0.81 – 0.90	–	–	–	–	–	–	–	–
0.91 – 1.00	–	–	–	–	–	–	–	–
Total	19 (100.00)	7 (100.00)	10 (100.00)	20 (100.00)	8 (100.00)	20 (100.00)	8 (100.00)	19 (100.00)
Mean	0.32	0.43	0.34	0.44	0.38	0.54	0.40	0.61

Overall technical efficiency in Block I is 0.45

(Figures in parentheses indicate percentage to total)

TABLE LXII

FREQUENCY DISTRIBUTION OF TECHNICAL EFFICIENCY OF VARIOUS CATEGORY OF FARMERS IN BLOCK II

Frequency	Landless labourer		Marginal farmers		Small farmers		Large farmers	
	Buffaloe	Cross bred cow	Buffaloe	Cross bred cow	Buffaloe	Cross bred cow	Buffaloe	Cross bred cow
0.10 - 0.20	-	-	-	-	-	-	-	-
0.21 - 0.30	-	1 (4.35)	2 (13.33)	2 (18.18)	4 (22.22)	2 (15.38)	2 (11.11)	-
0.31 - 0.40	4 (44.44)	6 (26.09)	3 (20.00)	3 (27.28)	6 (33.33)	4 (30.77)	7 (38.89)	-
0.41 - 0.50	3 (33.33)	7 (30.43)	7 (46.67)	-	3 (16.67)	-	6 (33.33)	4 (44.44)
0.51 - 0.60	2 (22.23)	6 (26.09)	2 (13.33)	4 (36.36)	2 (11.11)	1 (7.69)	2 (11.11)	3 (33.33)
0.61 - 0.70	-	3 (13.04)	1 (6.67)	2 (18.18)	2 (11.11)	6 (46.16)	1 (5.56)	2 (22.23)
0.71 - 0.80	-	-	-	-	1 (5.56)	-	-	-
0.81 - 0.90	-	-	-	-	-	-	-	-
0.91 - 1.00	-	-	-	-	-	-	-	-
Total	9 (100.00)	23 (100.00)	15 (100.00)	11 (100.00)	18 (100.00)	13 (100.00)	18 (100.00)	9 (100.00)
Mean	0.42	0.47	0.41	0.46	0.42	0.49	0.41	0.53

Overall Technical efficiency in Block II is 0.45

(Figures in parentheses indicate percentage to total)

TABLE LXIII

FREQUENCY DISTRIBUTION OF TECHNICAL EFFICIENCY OF VARIOUS CATEGORY OF FARMERS IN BLOCK III

Frequency	Landless labourer		Marginal farmers		Small farmers		Large farmers	
	Buffaloe	Cross bred cow	Buffaloe	Cross bred cow	Buffaloe	Cross bred cow	Buffaloe	Cross bred cow
0.10 - 0.20	-	-	-	-	-	-	-	-
0.21 - 0.30	-	-	-	-	-	3 (8.82)	-	-
0.31 - 0.40	4 (44.44)	1 (4.55)	-	3 (13.04)	-	5 (14.71)	2 (33.33)	1 (4.35)
0.41 - 0.50	3 (33.33)	8 (36.36)	3 (37.50)	5 (21.74)	2 (33.33)	8 (23.53)	2 (33.33)	7 (30.43)
0.51 - 0.60	2 (22.23)	7 (31.82)	4 (50.00)	8 (34.78)	3 (50.00)	9 (26.47)	2 (33.33)	8 (34.78)
0.61 - 0.70	-	4 (18.18)	1 (12.50)	6 (26.09)	1 (16.67)	7 (20.59)	-	4 (17.39)
0.71 - 0.80	-	2 (9.09)	-	1 (4.35)	-	2 (5.88)	-	3 (13.05)
0.81 - 0.90	-	-	-	-	-	-	-	-
0.91 - 1.00	-	-	-	-	-	-	-	-
Total	9 (100.00)	22 (100.00)	8 (100.00)	23 (100.00)	6 (100.00)	34 (100.00)	6 (100.00)	23 (100.00)
Mean	0.43	0.54	0.52	0.54	0.53	0.50	0.52	0.55

Overall technical efficiency in Block III is 0.52

(Figures parentheses indicate percetnage to total) practices fully and correctly. This implied that most of the farmers have not allocated their input efficiently and not operated efficiently and technically also. Hence a look of technical efficiency estimated from SF PF may be useful. The estimated farm specific technical efficiency through SFPF are presented in Table LXI,LXII and LXIII.

The efficiency ranges from 0.21 to 0.80. The over all mean value of efficiency of farm for the blocks I, II and III were 0.45, 0.45 and 0.52 respectively more than 50 per cent of the farm in all the categories operations below their respective mean level efficiency. The heterogeneity in management gains production practices facility available in the farm could explain the distribution of technical efficiency.

The distribution of technical efficiency of Buffalo milk yield was negatively skewed whereas cross bred cow was positively skewed which might be due the length of lactation.

4. OPTIMUM ENTERPRISE MIX

In the course of production at farm level farmers have to face various constraints. Identifying and Specifying the major constraints in the production process would facilitate to take up efforts to remove or reduce those constraints, which would have positive effect on income and efficiency. The existing and optimal plan for different categories of farmers in blocks I,II and III are presented in Tables LXIV,LXV and LXVI.

BLOCK I

In the existing plan of the landless category, the size of the dairy was one buffalo only. Taking into consideration on the resource availability, an optimal plan was developed and this indicated the size of the dairy as one cross bred cow only, with

EXISTING AND OPTIMAL PLAN FOR DIFFERENT CATEGORIES OF FARMER IN BLOCK I

Particulars	Units	Existing Plan				Optimal Plan				Sensitivity Analysis								
										Cross bred cow		Buffaloe						
										Con-centrate	Green fodder	Concentrate			Green fodder			
		LL	MF	SF	LF	LL	MF	SF	LF	LL	LL	MF	SF	LF	LL	MF	SF	LF
Operational area	Acre	0	3.20	4.54	8.21	0	2.20	4.54	8.21	0	0	2.20	4.54	8.21	0	2.2	4.54	8.21
Activities:																		
Tapioca	Acre	0	0.50	1.00	2.94	0	1.62	2.70	3.40	0	0	1.49	2.70	3.40	0	1.49	2.70	3.40
Sugarcane	Acre	0	1.20	1.50	2.42	0	0.58	1.84	4.12	0	0	0.71	1.84	4.40	0	0.71	1.84	4.12
Paddy	Acre	0	0.50	0.70	0.90	0	0	0	0	0	0	0	0	0	0	0	0	0
Groundnut	Acre	0	0	0.51	0.45	0	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	Acre	0	0	0.83	1.50	0	0	0	0.69	0	0	0	0	0.41	0	0	0	0.69
Buffalo	Number	1	2	2	1	0	2	2	2	2	1	2	2	2	0	2	2	2
Crossbred cow	Number	0	0	1	2	1	0	0	0	0	1	0	0	0	1	0	0	0
Net Return	Rs.	3767	8150	11955	12400	5191	10158	14780	15425	4875	5088	15002	14780	15339	5230	15002	14780	15425
Difference (Rs.)						1424	2008	2825	3025	–316	–103	4844	–	–86	39	4844	–	–
% of Differences						37.80	24.64	23.63	24.40	–6.09	–1.98	47.69	–	–0.56	0.75	47.69	–	–

an increased net income of 37.80 per cent. This indicated that the optimal allocation of available resources which induces a rise is income due to replacement of buffalo to crossbred cow.

The sensitivity analysis indicated fall in net return inspite of increase in number of the milch animals. This input be due to in adequate supply of inputs which lead to reduction in milk yield.

The optimal plan developed for marginal farmers indicated the allocation of 1.62 acres of land for tapioca and 0.58 acres of land for sugarcane with two buffaloes and a increased net income of 24.64 per cent. A Ten per cent increase in concentrate and green fodder showed a reduction in the area of tapioca by 8.20 per cent and an increase of 22.40 per cent of land for sugarcane without change in number of milch animals. This resulted in increase in net income by 47.69 per cent. This increase was mainly attributed by replacement of paddy by sugarcane and tapioca. It also supplemented fodder requirement of the milch animals.

The optimal plan developed for small farmers revealed that the area available for cultivation of tapioca and sugarcane were 2.70 acres and 1.84 acres respectively with the unit size of two buffaloes. The increase in net return in the optimal plan over the existing plan was Rs.2825 (23.63 per cent). This increase was mainly attributed by replacement of ground nut, paddy and cotton by sugarcane and tapioca.

The optimal allocation of land in the large farmers were 3.40 acres of tapioca, 4.12 acres of sugarcane and 0.69 acres of cotton with two buffaloes. The increase in net income of the optimal plan over the existing plan was Rs.3025/- (24.40 per

EXISTING AND OPTIMAL PLAN FOR DIFFERENT CATEGORIES OF FARMER IN BLOCK II

Particulars	Units	Existing Plan				Optimal Plan				Sensitivity Analysis							
										Cross bred cow		Buffaloe					
										Con-centrate	Green fodder	Concentrate			Green fodder		
		LL	MF	SF	LF	LL	MF	SF	LF	MF	MF	LL	SF	LF	LL	SF	LF
Operational area	Acre	0	1.85	4.20	7.60	0	1.85	4.20	7.60	1.85	1.85	0	4.20	7.60	0	4.20	7.60
Activities																	
Tapioca	Acre	0	1.10	1.45	2.45	0	1.85	2.15	2.70	1.02	1.85	0	2.40	2.70	0	2.15	2.70
Sugarcane	Acre	0	0	0	3.15	0	0	0	3.40	0.83	0	0	0	3.61	0	0	3.40
Paddy	Acre	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Groundnut	Acre	0	0	0.92	0	0	0	0.41	0	0	0	0	0.61	0	0	0.41	0
Cotton	Acre	0	0.75	1.83	2.00	0	0	1.64	1.50	0	0	0	1.19	1.29	0	1.64	1.50
Buffalo	Number	1	1	1	2	1	0	2	2	2	1	0	2	2	0	2	2
Crossbred cow	Number	0	0	1	1	0	1	0	0	0	0	1	0	0	1	0	0
Net Return	Rs.	2964	9976	10865	12475	2964	14315	15158	15380	14582	14315	3121	15094	15292	3121	15158	15380
Difference (Rs.)	–	–	–	–	–	–	4339	4293	2905	267	–	157	–64	–88	157	–	–
% of Differences	–	–	–	–	–	–	43.49	39.51	23.29	1.87	–	5.29	–0.42	–0.54	5.14	–	–

cent). This increase was mainly contributed by reallocation of land among tapioca and sugarcane which augmented the fodder requirements.

BLOCK II

The optimal plan developed for land less dairy farmers exactly consider with the existing farm plan. Ten percent increase in the level of concentrate, the landless category shifted over to crossbred cow resulting in the increased net return by 5.14 per cent. The same was the case for ten per cent increase in green fodder.

In case of marginal farmers, the optimal allocation of land for tapioca was 1.85 acres with a change from buffalo to crossbred cow and net income increased to 43.49 per cent. Ten per cent increase in concentrate had little effect on net return.

The optimal plan developed for small farmers revealed an increased net return of Rs.4293 (39.50 per cent) with reallocation of land for tapioca (2.15 acres), ground nut (0.41 acres) and cotton (1.64 acres) with unit size of two buffaloes. Net income remains un affected by an increase of 10 per cent in the value of concentrate and green fodder.

In the optimal plan for large farmers, the minimum area allotted to meet the increased income of 23.29 per cent, for different crops viz., 2.70 acres of tapioca 3.40 acres of sugarcane and 1.50 acres of cotton respectively and two buffaloes only. This increase might be contributed by increase in the area allotted to tapioca and sugarcane. The optimum plan suggested two buffaloes, for which the feed and fodder requirement could be met from the farm itself.

BLOCK III

In the optimal plan developed for land less, the minimum unit size was one cross bred cow with an increase in income by Rs.959/- (26.57 per cent) over the existing plan. This was because of replacement of buffalo by cross bred cow.

There was an increase in income of Rs.1956/- (20.89 per cent) when the marginal farmers switch over to two cross bred cows with 1.72 acres of paddy and 0.43 acres of groundnut. This might be due to introduction of cross bred cow and the proposed crop mix supplemented the fodder requirements.

In the optimum plan for small farmers, the minimum area required to increase the net income was Rs.3662 (36.33 per cent), the land allotted was 3.72 acres of paddy and 1.08 acres of groundnut with no change in the unit size of the milch animals over the existing plan.

The optimal plan developed for the large farmers revealed an increase in income of Rs.3398 (30.08 per cent) with reallocation of land for paddy (5.10 acres) and ground nut (2.00 acres) with three cross bred cows. This increase might be due to increase in the number of cross bred cows.

The optimal plans developed for landless category for blocks I and III indicated replacement of buffalo by crossbred cow resulted in a minimum increase in net income of Rs.3610/-. This is because of the adoption of better breeding and management practices and also availability of fodder.

In case of marginal farmers in the blocks II and III, the net return was increased by the introduction of crossbred cow which indicated the efficiency of marginal farmers.

TABLE LXVI

EXISTING AND OPTIMAL PLAN FOR DIFFERENT CATECORIES OF FARMER IN BLOCK III

Particulars	Units	Existing Plan				Optimal Plan				Sensitivity Analysis Cross bred cow: Concentrate				Sensitivity Analysis Cross bred cow: Green fodder			
		LL	MF	SF	LF	LL	MF	SF	LF	LL	MF	SF	LF	LL	MF	SF	LF
Operatinal area	Acre	0	2.15	4.80	7.10	0	2.15	4.80	7.10	0	2.15	4.80	7.10	0	2.15	4.80	7.1
Activities:																	
Paddy	Acre	0	1.55	3.44	5.41	0	1.72	3.75	5.10	0	1.55	3.44	5.10	0	1.55	3.44	5.1
Groundnut	Acre	0	0.60	1.36	1.69	0	0.43	1.08	2.0	0	0.60	1.36	2.0	0	0.60	1.36	2.0
Buffalo	Number	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cross bred cow	Number	0	1	2	2	1	2	2	3	1	2	2	3	1	2	2	3
Net Return	Rs.	3610	9362	9915	11295	4569	11318	13577	14693	4423	11318	13577	14693	4569	11318	13577	14693
Difference (Rs.)						959	1956	3662	3398	-146	–	–	–	–	–	–	–
% of Differences						26.57	20.89	36.93	30.08	-3.20	–	–	–	–	–	–	–

Where as marginal farmers in block I showed increase in net income of 24.60 per cent with buffalo which might be due to the enterprise mix.

Both small farmers and large farmers in the block I and II preferred buffalo and also the net income increased to more than 23.29 per cent which might be due to the reallocation of available land among the enter prices which supplemented the inputs required for the milch animals.

In block III all the categories of farmer shifted to cross bred cow and received more than 20.89 per cent of net income. Which might be due to the enterprises selected, awareness about cross bred cows and the availability of inputs throughout the year.

5. CONSTRAINTS IN MILK PRODUCTION

The constraints faced by the sample farmers in milk production were analysed and presented in Tables LXVII, LXVIII and LXIX.

It could be seen from the Table LXVII that the constraints faced by the block I farmers in milk production were i) low price of milk, ii) ii) low productivity iii)high investment,iv) high cost of feed v) inadequate input, vi) vi)repeat breeding problem, vii) frequently become sick, viii) inadequate infrastructure for milk marketing and ix) costly veterinary treatment and aid.

In case of block II farmers the major constraints were i) inadequate input, ii) low productivity ,iii) low price of milk, iv) iv) high investment, v) repeat breeding vi) high cost on feed, vii) inadequate infrastructure for milk marketing, viii) frequently become sick and ix) costly veterinary treatment and aid.

TABLE LXVII

CONSTRAINTS IN MILK PRODUCTION REVEALED BY BLOCK I SAMPLE FARMERS

Constraint	Mean score	Rank
Low price of milk	73.41	I
Low productivity	69.01	II
High investment	54.62	III
High cost of feed	53.17	IV
Inadequate input supply	50.22	V
Repeat breeding problem	45.32	VI
Frequently become sick	35.75	VII
Inadequate infrastructure for milk marketing	30.22	VIII
Costly veterinary treatment and aid	20.15	IX

TABLE LXVIII

CONSTRAINTS IN MILK PRODUCTION REVEALED BY BLOCK II SAMPLE FARRMERS

Constraint	Mean score	Rank
Inadequate input supply	67.52	I
Low productivity	64.21	II
Low price of milk	64.00	III
High investment	44.44	IV
Repeat breeding problem	32.71	V
High cost of feed	30.18	VI
Inadequate infrastructure for milk marketing	25.21	VII
Frequently become sick	20.42	VIII
Costly veterinary treatment and aid	15.14	IX

TABLE LXIX

CONSTRAINTS IN MILK PRODUCTION REVEALED BY BLOCK III SAMPLE FARMERS

Constraint	Mean score	Rank
High cost of feed	76.74	I
High investment	72.41	II
Low price of milk	69.33	III
Inadequate infrastructure for milk marketing	60.10	IV
Low productivity	55.44	V
Inadequate input supply	40.11	VI
Costly veterinary treatment and aid	35.22	VII
Frequently become sick	20.17	VIII
Repeat breeding problem	10.54	IX

The various problems in milk production of block III farmers were ranked and were in the order of i) high feed cost, ii) high investment, iii) low price of milk, iv) inadequate infrastructure for milk marketing, vi) low productivity, vi) inadequate input, vii) costly veterinary treatment and aid,viii) frequently become sick and ix) repeat breedingproblem.

It is evident from the Tables LXVII,LXVIII and LXIX that the productivity of milch animals could be increased by adopting scientific feeding and breeding management. The infrastructure need to the strengthened interms of fodder production, artificial insemination, health cover, marketing and extension agencies are very much required in the study area. The technology transfer efforts is still in the infant stage which underscores strengthening at village level for reaping more benefits from dairying.

SUMMARY AND CONCLUSIONS

CHAPTER VI

SUMMARY AND CONCLUSIONS

Resources, being limited and scarce in agriculture, limit the farm production and thereby the net income from farm production. In this context, optimal use of the available resources in the farms under different production environments assumes a greater importance. There arises a need to enable the farms to utilise the resources by allocating them among alternative production activities alternatively to meet the objective of profit maximisation.

The estimation of cost and its comparison with prices realised by the producers are axiomatic in portraying the economic viability of an enterprise which ultimately decides the soundness of the investment made and resource planning for the near future. A working hypothesis is that a treatise on the relative contribution of various components to cost of milk production can bestow some valuable clues to reduce the cost of production, increase resource use efficiency and farm income could be increased through optimal crop mix and dairy enterprise. Hence an attempt was made to know the current status, problems and prospects of dairy farms in Dharmapuri district of Tamil Nadu.

The specific objectives of the study were to examine the existing status of dairying, to analyse the constraints in dairying with reference to factors and products and to suggest alternative plans to augment income and employment.

Dharmapuri district of Tamil Nadu was purposively selected for this study. Using multi stage random sampling, three taluks were selected, then one block from each taluk was selected and finally two villages from each block were selected by probability proportion method. A sample of 360 farmers were selected randomly from the selected six villages and cross section data related to the fiscal year 1995-96 were gathered. The sample were post stratified into four categories viz., landless, marginal farmers,small farmers and large farmers based on the size of operational holding. Simple average and percentage, stochastic frontier production function, linear programming and Garett ranking techniques were employed as tools of analysis for this study.

Post stratification of 360 sample farmers resulted in 24.72 per cent of landless, 24.17 per cent of marginal farmers, 27.50 per cent of small farmers and 23.61 per cent of large farmers for all the blocks.

The literacy level of sample farms showed that 92.50 per cent of the head of the sample farmers were literate. In case of large farmers, all were literate and the percentage of graduate education was highest in block I (55.17) followed by blocks II and III, in that order.

The analysis of asset position revealed the predominance of land component, with maximum of 83.61 per cent of the total assets in large farmer category of block III followed by buildings, wells, livestock, machinery and tools and implements. The asset position per acre generally increased with the farm size.

The structure of milch animal composition revealed that buffaloes were preferred among landless and marginal farmer categories and cross bred cows were preferred by large farmers indicating that buffaloes need less of resources, while cross bred cows demand more of them. Among the selected farmers, the number of buffaloes were found to be higher, followed by cross bred cows in blocks I and II where as it was reverse in block III.

The investment pattern indicated that the landless invested about 98 per cent on buffaloes and cross bred cows followed by marginal,small and large farmers for all the blocks. The large farmers invested to the tune of 10.73 per cent on buildings.

The total fixed cost per milch animal per lactation for buffaloe was lower as compared to cross bred cow. The interest on investment was the major component of the fixed cost.

The total variable cost per milch animal per lactation was highest for cross bred cows followed by buffaloes in all the blocks for all the categories of farmers. The share of feed cost was more than 70 per cent for all the categories of farmers for all the three blocks, of which concentrates formed the major share (24 per cent). The maintenance cost was found to be more in cross bred cows than in buffaloes irrespective of the size of holding.

The net return was highest for buffaloes in all the categories of farmers in block I, where as in case of cross bred cows, the highest net income of Rs.3786.43 was realised in landless category of block II.

The cost of milk production per litre was lowest in cross breds followed by buffaloe in all the categories of farmers in all the three blocks. Among different categories of farmers, the per litre cost of production of buffaloe milk was found to be higher (Rs.6.41) in case of small farmer in block III whereas in cross breds the cost of among marginal farmer category of block I.

It was found that large farmer category ranks first in milk production, to the tune of 10.20 litres per day per animal and the quantity of milk retained for onfarm consumption by different categories of farmers increased with increase in land holdings. On an average 85.50 per cent in block I,72.88 per cent in block II and 88.29 per cent in block III of different categories of farmers sold milk to milk producers' cooperative societies. This higher proportion might be due to their faith on the co-operatives.

The average feed consumed per milch animal was worked out and found that the consumption of dry fodder was more in block II for all the categories of farmers and the use of concentrate was found to be higher and increased with increase in size of holdings in all the categories of farmers for all the blocks. The consumption of green fodder was found to be more in cross bred cows (14.71 kgs.) in block I of marginal farmer category.

The analysis of labour use revealed that the family labour use decreased with increase in size of holding and the permanent labour use increased with increase in size of holding.

The cost of cultivation of different crops in the sample farms for all the three blocks under different categories were worked out and found that the cost of cultivation as well as net return per acre of sugarcane was found to be more irrespective of the size of holding for all the three blocks. The share of plant protection chemicals and cost of fertilizers and manures were higher in cases of cotton and sugarcane for all the categories of farmers in all the blocks.

To know the resource productivity in dairying, stochastic frontier production function was chosen and the functional analysis revealed that in block I, for all the categories of farmers, estimated coefficients of multiple determination were greater than 0.69 and statistically significant indicating the goodness of fit. The elasticity coefficient of concentrate is statistically significant at five per cent level in the estimated functions for the landless,marginal and large farmer categories where as it was non significant in small farmers. The coefficient of cost of health care was significant in the landless category which might be due to better management practices adopted by them as this was the only source of income for the landless. The breed dummy variable for landless and small farmer of block I were significant indicating that the milk yield could be increased by cross bred cows.

All the estimated coefficients in all the functions in all the categories of farmer were numerically less than unity,indicating that their use was in the technically rational region of production and they have significantly contributed to milk production.

The 't' test revealed the existence of decreasing returns to scale in marginal farmers, increasing returns to scale for large farmers and constant returns to scale in landless and small farmers.

In block II, the elasticity coefficient of concentrate was statistically significant in the estimated functions of landless, marginal and small farmers which implied the significant contribution of concentrate to milk yield. The significant negative sign for the coefficient of dry fodder calls for reallocation of various inputs to maximise the milk yield. The 't' test indicated the existence of constant returns to scale in marginal and small farmers with numerical values slightly less than unity which might be due to the fact that the excluded factor inputs varied less proportionately with changes in the included factor input over the sample of observations.

Significant elasticity coefficient was obtained for concentrate in landless,small farmers and large farmers in block III. The significant coefficient attached to dummy variable except in large farmer indicated the contribution of cross bred cows to the milk yield. The negative non significant elasticity coefficients of labour in landless and marginal farmers implied excessive use of human labour in the maintenance of milch animals. The sum of the production elasticities ranged from 0.19 to 0.06 indicated the existence of decreasing return to scale in all the categories of farmers.

The technical efficiency ranges from 0.21 to 0.80. The overall mean value of efficiency of farm for the blocks I,II and III were 0.45,0.45 and 0.52 respectively. More than 50 per cent of the farm in all the categories were operating below their respective mean level efficiency. The distribution of buffaloe milk yield was negatively skewed whereas cross bred cow was positively skewed and which might be due to the length of lactation.

Optimal plan was developed for landless category in block I and indicated that inclusion of one cross bred cow in place of buffaloe results in increased net income of 37.80 per cent. The sensitivity analysis indicated a fall in net return inspite of increase in number of milch animals. The optimal plan developed for marginal farmers indicated the allocation of 1.62 acres of land for tapioca and 0.58 acres of land for sugarcane with two buffaloes would result in an net income increased to 24.64 per cent.

The optimal plan developed for small farmers revealed that the area available for cultivation of tapioca and sugarcane were 2.70 acres and 1.84 acres respectively with the unit size of two buffaloes and the net income increased to 23.71 per cent. The optimal allocation of land in the large farmers were 3.40 acres of tapioca,4.12 acres of sugarcane and 0.69 acres of cotton with two buffaloes and the increase in net income of the optimal plan over the existing plan was Rs.3025.

In block II, the optimal plan of landless category exactly coincide with the exiting farm plan whereas a ten per cent increase in concentrate and green fodder shifted to cross bred cow resulting in increased net return by 5.14 per cent. In case of marginal farmers,the optimal allocation of land for tapioca was 1.85 acres with a change from buffaloe to cross bred cow and net income increased to 43.49 per cent whereas small farmers received an increased net return of Rs.4283 (39.51 per cent) with reallocation of land for tapioca (2.15 acres), groundnut (0.41 acres) and cotton (1.64 acres) with unit size of two buffaloes. The net income remains unaffected by an increase of 10 per cent in the value of concentrate and green fodder.

In the optimal plan for large farmers,the minimum area allotted to meet the increased income of 23.29 per cent for different crops viz., 2.70 acres of tapioca,3.40 acres of sugarcane and 1.50 acres of cotton respectively with two buffaloes.

In block III, all the categories of farmers shifted to cross bred cows and received more than 20.89 per cent of net income which might be due to the enterprises selected and the availability of inputs throughout the year.

The constraints in milk production for block I were ranked and are in the order of low price of milk, low productivity , high investment,high feed requirement, inadequate input, repeat breeding problem, inadequate infrastructure for milk marketing and costly veterinary treatment and aid whereas for block II the constraints are in the order of inadequate input, low productivity, lower price of milk, high investment, repeat breeding problem, high feed requirement, inadequate infrastructure for milk marketing, frequently become sick and costly veterinary treatment and aid.

The various problems revealed by block III farmers in milk production are high feed cost, high investment, lower price of milk, inadequate infrastructure for milk marketing, low productivity, inadequate input, costly veterinary treatment and aid, frequently become sick and repeat breeding problem.

POLICY IMPLICATIONS

Efficient utilisation of the available resources plays a crucial role in maximising the net income from farms. So, the optimal use of available resources among the farm situations and farm sizes assumed greater significance and the results of this study suggested the following.

1. The distribution of milch animals was more skewed towards small farmers and large farmers which necessitates suitable credit policies directed towards the landless category and marginal farmers.

2. Feed cost, the major share of total cost, may be reduced by the incorporation of tapioca starch waste in the preparation of compounded feed in block I and II and wheat bran in block III. Commercial feed manufacturing units and community grasslands can be developed for intensive fodder production.

3. The feed price to milk price ratio may be maintained at appropriate levels.

4. Labour, next to feed, occupied a large share of the gross cost which reiterates the labour intensive nature of dairying that can be subjected for further detailed analysis.

5. The cost of production of milk was lowest for cross bred cows but this advantage is offset by the pricing policy favoring buffalo milk. Present pricing policy of milk needs thorough examination in the light of the above finding.

6. The distribution pattern of cows and buffaloes indicates that block specific recommendations are needed for policy prescriptions.

7. More than 50 per cent of all the categories of farmers operating below their respective mean level efficiency which warranted reallocation of inputs to get maximum output.

8. The farmers of blocks I and II may be advised to rear more numbers of buffaloes with tapioca and sugarcane as major crops and the block III farmers may be advised to rear cross bred cows with paddy and groundnut as major crops.

9. The study suggests, to increase milk production in buffaloe and cross bred cows, the infrastructure facilities need to be strengthened in terms of fodder production, artificial insemination with frozen semen, health cover and extension agencies. The services of extension agencies are very much required for further development in the sector concerned, in the study area.

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APPENDIX

APPENDIX II

(Stochastic Frontier Production Function, Maximum Likelihood Estimation Procedure)

The ML estimators of θ, maximising the likelihood function

$$\ln L(y,\theta) = -\frac{n}{2}\ln\frac{\pi}{2} - \frac{n}{2}\ln\sigma^2 + \Sigma\ln(1 - F(Z_i)) - \frac{1}{2}\left(\frac{1-\gamma}{\gamma}\right)\Sigma Z_i^2$$

where

$$Z_i = (y_1 - \Sigma x_{ij}\beta_j)\left[\left(\frac{\gamma}{1-\gamma}\right)\frac{1}{\sigma^2}\right]^{\frac{1}{2}}$$

are obtained by setting first oder partial derivatives with respect to β, σ^2 and γ equal to zero, that is,

$$\frac{\delta L}{\delta\beta} = 0,\ \frac{\delta L}{\delta\sigma^2} = 0 \text{ and } \frac{\delta L}{\delta\gamma} = 0 \text{ and solving them simultaneously.}$$

$$\frac{\delta L}{\delta\beta} = -\sum_{i=1}^{n}\frac{1}{1 - F(\omega_i)}\cdot\frac{\delta F(\omega_i)}{\delta\omega_i}\cdot\frac{\delta\omega_i}{\delta\beta} - \frac{1}{2}\left(\frac{1-\gamma}{\gamma}\right)\cdot 2\,\Sigma\omega_i\frac{\delta\omega_i}{\delta\beta} = 0 \quad \text{... (1)}$$

and

$$\frac{\delta F(\omega_i)}{\delta\omega_i} = \frac{1}{\sqrt{2\pi}}\exp\left(\frac{\omega_i^2}{2}\right) : \frac{\delta\omega}{\delta\beta_i} = -x_{ij}\left[\left(\frac{\gamma}{1-\gamma}\right)\frac{1}{\sigma^2}\right]^{\frac{1}{2}}$$

$$\frac{\delta L}{\delta\sigma^2} = \frac{n}{2\sigma^2} + \sum_{i=1}^{n}\frac{1}{1 - F(\omega_i)}\cdot\frac{\delta F}{\delta\omega_i}\cdot\frac{\delta\omega_i}{\delta\sigma^2} - \frac{1}{2}\left(\frac{1-\gamma}{\gamma}\right)\cdot 2\,\Sigma\omega_i\frac{\delta\omega_i}{\delta\sigma^2} = 0 \quad \text{... (2)}$$

where

$$\frac{\delta\omega_i}{\delta\sigma^2} = -\frac{1}{2}\frac{\omega_i}{2\sigma^2}$$

and

$$\frac{\delta L}{\delta\gamma} = -\sum_{i=1}^{n}\frac{1}{1 - F(\omega_i)}\cdot\frac{\delta F(\omega_i)}{\delta\omega_i}\cdot\frac{\delta\omega_i}{\delta\gamma} + \frac{1}{2\gamma^2}\Sigma\omega_i^2 - \frac{1}{2}\left(\frac{1-\gamma}{\gamma}\right)\cdot 2\,\Sigma\omega_i\frac{\delta\omega_i}{\delta\gamma} = 0 \quad \text{... (3)}$$

where

$$\frac{\delta \omega_i}{\delta \gamma} = -\frac{\omega_i}{2\gamma(1-\gamma)}$$

In practice it is very difficult to solve the simultaneous equations (1), (2) and (3) to obtain the maximum likelihood estimators. That can be done only by approxiated numerical methods. Newton-Raphson technique is the most appropriate for this. But Kale (1962), to reduce the overshooting, (whether the successive estimators overshoot the true solution or not) suggested a light modificatoin over Newton- Raphson technique, which involves controlling the measurement of the successive estimators from the initial estimator through a predetermined specified proportion of change. The modified Newton- Raphson estimator is

$$\theta_1 = \theta_0 - \alpha \left[\frac{\delta^2 L(y,\theta_0)}{\delta\theta \cdot \delta\theta'}\right] \cdot \frac{\delta L(y,\theta_0)}{\delta\theta}$$

where

$$\frac{\delta L}{\delta \theta} \text{ and } \frac{\delta^2 L}{\delta\theta \cdot \delta\theta'}$$

are the first and second order partial derivatives of the likelihood function evaluated at the initial parameter θ_0 represents the specified proportion of change and is constant ranging from 0 to 1.

Selecting the initial estimate in the neighbourhood of the maximum of the function may be done in the following way (Kaliarajan, 1982). It is reasonable to expect the estimates of the frontier function to be as high as the OLS estimates of the poduction function showing average techology. So, the initial estimator θ_0 is assumed to have respectively β_0, β_i 's and σ^2 as the OLS estimates showing the intercept (β_0) and otherparameter (β_i 's) and the residual variance. Thus, OLS estimates serve as lower