"WATER SCARCITY CONDITION IN TAIL END OF CAUVERY DELTA ZONE- SOCIO ECONOMIC IMPLICATIONS AND FARMER'S SURVIVAL STRATEGIES"

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KARAIKAL – 609 603

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"WATER SCARCITY CONDITION IN TAIL END OF CAUVERY DELTA ZONE- SOCIO ECONOMIC IMPLICATIONS AND FARMER'S SURVIVAL STRATEGIES"

Thesis submitted in part fulfillment of the requirement for the Degree of **Master of Science** (Agriculture) In **Agricultural Economics** to the Tamil Nadu Agricultural University, Coimbatore.

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CERTIFICATE

This is to certify the thesis entitled **"Water Scarcity Condition in tail end of Cauvery delta zone - Socio Economic Implications and Farmer's Survival Strategies"** submitted in part fulfillment of the requirements for the award of the degree of **Master of Science** (Agriculture) in **Agricultural Economics** to the Tamil Nadu Agricultural University, Coimbatore is a record of ***bonafide*** research work carried out by **Ms. P. Mageswari @ Rajakumari** under my supervision and guidance and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journal or magazine.

Place: Karaikal **(Dr. P. NASURUDEEN)**

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ABSTRACT

WATER SCARCITY CONDITION IN TAIL END OF CAUVERY DELTA ZONE - SOCIO ECONOMIC IMPLICATIONS AND FARMER'S SURVIVAL STRATEGIES

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2004

An attempt was made to study the impact of drought or water scarcity conditions and to identify the survival strategies of the farm households in the tail end region of Cauvery delta zone. Eventhough technological advancement in agriculture sector tremendously increased the scope for the commercialization, the weather factors, especially rainfall plays truant in agriculture. The result of monsoon failure or no release of water in Cauvery River made havoc in this region for the past three years successively.

To know the impact of water scarcity conditions on the farm economy of this region, this study was carried out in Nagapattinam district and Karaikal region of U.T of Pondicherry. The data were collected from 90 farms in nine villages of Sembanarkoil block in Nagapattinam district, and 30 farms from three villages of Thirunallar commune in Karaikal region where paddy was cultivated in a larger area under canal irrigation system. The ultimate sample size was 120.

The data collection was undertaken during the months of May and June 2004. Data were collected from the sample respondents for the drought year 2003-2004 to study the farm level consequences of drought. For the purpose of comparative analysis between drought and non-drought years, data were collected from the respondents for the normal year 2000-2001 also. Therefore, the reference years for the study were 2000-01 (normal year) and 2003-04 (drought year). To address the proposed objectives of the study, data were collected from both the primary and secondary sources. Primary data on age, education, household size, land use pattern, cropping pattern, yield, and cost of cultivation, and employment, income and expenditure pattern of households were collected through a well structured and pre-tested interview schedule by survey method for both drought and normal years.

The land holding pattern of the sample households revealed that the average size of the operational holding was 1.13 and 1.23 ha in drought and normal years respectively in Nagapattinam district whereas in Karaikal region, it was 1.23 and 1.29 ha for the same period. The characteristic feature of the sample farms in Nagapattinam district was that wetlands were cultivated by owners themselves. Canals and borewells were the major source of irrigation, which together accounted for more than 80 per cent of gross irrigated area. The cropping pattern indicated that paddy was the major crop grown in the study area. Majority of the respondents followed paddy – paddy – pulses rotation in normal year whereas during drought year most of them followed paddy – pulses rotation, paddy only, paddy-cotton etc and the land was left as fallow in the third season.

The various instability indicators like coefficient of variation, probability of crop failure and crop loss ratio were worked out to examine the nature, extent and magnitude of instability in all the three seasons for the period from 1972-73 to 2000-01 in Karaikal region and 1992-93 to 2002-03 in Nagapattinam district. The instability indices indicated a higher variability in third season when compared to other seasons in both the study areas.

The impact of rainfall on crop yields which was estimated by multiple regression model showed that the seasonal deviation in rainfall, Cauvery water release in the first season and in the second season, rainfall and irrigated area were the major

factors influencing variation of crop yield from the mean level in Nagapattinam district, whereas in Karaikal region, rainfall in the first season, rainfall and irrigated area in the second season were the major factors influencing variation of crop yield.

The cost of cultivation of paddy was worked out for both drought and normal years and the results indicated that the absolute cost of almost all the operations declined significantly in the drought year making the decline in cost of cultivation by 24.96 per cent per hectare in Nagapattinam district and 12.60 per cent per hectare in Karaikal region. The result implies that inputs used for the cultivation of paddy declined in drought year when compared to the normal year.

The pattern of employment and income generation showed a reduction in employment opportunities by 28.74 per cent in Nagapattinam district and by 19.75 per cent in Karaikal region during drought year when compared to the normal year. While on-farm and non-farm activities were the major sources of employment during the normal year, there was a change in the occupational structure of farms in the event of drought. The on-farm employment declined by 38.03 per cent and 36.21 per cent during drought year when compared to the normal period in Nagapattinam district and Karaikal region. The non-farm employment increased by 48.91 and 67.72 percent in Nagapattinam district and Karaikal region respectively during the drought period. Due to drought, the average income of the sample households reduced by 31.58 and 30.73 percent respectively in Nagapattinam district and Karaikal region .The reduction in on-farm income has been compensated by increase in non-farm income by 127.80 per cent in Nagapattinam district whereas in Karaikal region, it was 117.73 per cent.

The consumption expenditure of food and non-food items indicated that expenditure varied considerably between the small and large farms in normal and drought year. In Nagapattinam district, the decline in consumption expenditure of food items in the drought year (as compared to the normal year) was 21.69 per cent in small farms and 14.02 per cent in large farms. whereas in Karaikal region, the magnitude of decline was 22.61 per cent in small farms and 11.23 per cent in large farms. The consumption expenditure of non-food items for drought year declined by 22.05 percent in small farms and by 15.27 per cent in large farms of Nagapattinam

district and in Karaikal region it was 20.66 and 10.48 per cent in small and large farms respectively.

Herfindahl index was used to estimate crop and farm diversification in drought and normal year. The result indicated that the farms were not adopting any crop diversification in the drought year when compared to the normal year. In case of farm diversification, the result of the study indicated that increased diversification was observed in small farms than on large farms in order to sustain household income in drought year. So there is a good scope to increase the income through farm diversification.

Cumulative food security index revealed that large farms were more food secured than small farms during the drought year. Among the coping strategies of the sample respondents, the less preferred coping strategies were limiting the quantum of consumption, skipping meals and going to relative's houses

Food demand estimates and elasticities derived from the Almost Ideal Demand System (AIDS) model for normal and drought period, reflected the reality in food consumption pattern of selected households in the study area. During normal year, some goods were complementary in nature but the components of complementary commodity basket have changed altogether during the drought period. The fall in consumption of pulses, oils, vegetables and fruits during drought year in the study area due to reduction in income would deprive the farms of proteins vitamins, fats and minerals thereby hampering the nutritional security of the sample respondents in the study area.

The various survival strategies adopted by the farm households were income diversification, migration, asset disposal, credit borrowings, and deferment of social and religious obligations. During the normal year, crop, livestock and wage earnings were the major source of income in small farms in the study area, whereas in drought year, transfers and migratory income occupied a major share. Because of the reduction in crop and livestock income during the drought, farms tried to compensate their reduced income through non-crop sources like sale of livestock, assets, farm equipments, jewels, wage labourers and non-agricultural labourers. The share of non-

crop income was 86.71 per cent in small farms and 73.14 per cent in large farms in Nagapattinam district, whereas in Karaikal region, it was 89.13 per cent in small farms and 73.61 per cent in large farms. The depletion of assets particularly productive assets like livestock and farm machinery during drought, reduced farms capacity for investment and hence they were forced to borrow money for resuming the farm activities. About 30 per cent of the sample households in both the regions postponed their social and religious obligations during drought year.

CONTENTS

LIST OF TABLES

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LIST OF FIGURES

CHAPTER I
INTRODUCTION

Technological progress has revolutionized Indian agriculture. The "Green Revolution" along with the package approach comprising of massive investment in irrigation, supportive measures of government, research efforts of scientists and innovative techniques of extension personnel coupled with the hard work and enterprising spirit of farming community have enhanced the productivity and production of both food and non-food crops. The production of foodgrains increased from 108.4 million tonnes in 1970-71 to 212.0 million tonnes in 2000-01. This was possible with the expansion of irrigated area under foodgrains from 24.1 per cent to 43.9 per cent of the total irrigated area during 1970-71 to 2000-01. Consequently, the per capita availability of foodgrains remained stable at around 455 grams per day and the incidence of poverty reduced from 54.9 per cent to 26.1 per cent over the three decades (Economic Survey, 2002).

Inspite of the technological advancements, the hold of weather on agricultural production continues to be a force to be reckoned with (Rao, 1964). Among the weather factors, rainfall is the most important factor influencing crop growth. The frequent failure of rainfall creates water scarcity situation resulting in droughts in several parts of the country. Statistically, for every seven good seasons there occur atleast two or three bad seasons in India. The drought climatology of the country showed that on an average, drought might be experienced over large areas on 20-25 per cent of the occasions in each of the months of the kharif season. Taking the criteria of drought as deficiency from normal rainfall by 20 per cent and more, analysis of rainfall data during 1870-1990 across 35 meteorological sub-divisions of India by the Central Research Institute for Dry land Agriculture (CRIDA) revealed that one-fifth of the total geographical area experienced drought once in five years, one - third once in 10 years and one- half once in 50 years (Katyal, 1995).

In India, 99 districts have been identified as drought prone by the Government of India based on three criteria viz., rainfall, past occurrence of drought and extent of net irrigated area. About 19 per cent of the geographical area was drought prone,

which was a source of livelihood for 12 per cent of the total population of the country (Karanth, 1995). It was estimated that atleast 150 million people in the states of Rajasthan, Gujarat, Madhya Pradesh, Orissa, Bihar, Chattisgarh, Himachal Pradesh and Maharashtra had no access even to food during the recent drought in 2001-02.

The impact of drought depends on its intensity, relief measures and resilience of the economy to withstand the adverse consequences of drought. The immediate and visible effect is the loss in output of both food and non-food crops with spill over effects on all sectors of the economy. Hence, it is aptly said that, "Drought in India means a lock-out in the agricultural industry as a whole" (Dubashi, 1992). Drought causes reduction in cropped area, input use, productivity, employment, and income ultimately affecting consumption leading to reduced calorie intake of households. Among the rural households, the distress of drought is borne more by the marginal farmers, landless laborers and artisans.

The households tend to adjust and adapt themselves to mitigate the adverse consequences of drought. Generally, farmers reduce the risk of water scarcity through change in agronomic practices and diversification of crops. The risk coping strategies of farmers could be ex-ante and or ex-post (Pandey *et al*, 2002). The ex-post strategies were consumption smoothing strategies, which include measures like migration, sale of assets and reduction in consumption. Reduced application of inputs, adjustment in area allocated to crops and postponement of agricultural decisions until the reduction in intensity of calamities were some of the ex-ante strategies. The pattern of adjustments in production and consumption vary among the different categories of households.

Among the states in India, Tamil Nadu is a water-starved state with annual per capita water availability of 600 m^3 against the national average of 4000 m^3. The irrigation potential is about 0.08 ha in per capita terms compared to the all India average of 0.17 ha (Palanisamy, 2002). Hence, the socio-economic repercussions of drought in the state were very severe which was evident during the recent drought year (2001-02), when out of 2.1 lakh ha of cropped area, about 0.98 lakh ha were affected resulting in a production loss to the tune of Rs.255.54 crore

The Cauvery delta command often referred to, as the 'Granary of South India' is a major irrigation system situated in eastern Tamil Nadu. Out of the net irrigated area of 27.1 lakh hectares, 85 per cent area is located in the Cauvery basin, which reflects the heavy dependence of the state on Cauvery water. The Cauvery basin covers major parts of Karnataka, Tamil Nadu, Karaikal in UT of Pondicherry and small parts of Kerala. The unresolved river water dispute between Tamil Nadu and Karnataka and the recurring monsoon failures result in acute water scarcity conditions and frequent crop failures and the tail end of the zone is the most affected. The tail end area accounts for 3.25 lakh ha, which is 22.4 per cent of the Cauvery delta zone.

Water was released from the Mettur reservoir and the normal flow was 350 to 400 TMC every year until 1974, which later declined to 220 TMC and below. A minimum of 55 TMC is required to open the sluices of the dam for irrigation purpose. In a normal year, water is released on June 12th to enable farmers raise Kuruvai and Samba crop. Only in six out of last 14 years the Mettur reservoir was opened on June 12th for irrigation (Hindu, 2004). The delta farmers normally grow samba rice in single crop low lands during August - September and if water facilities are available, two crops of rice are raised during Kuruvai (June-July) and Thaladi (Sept-Oct) with short and medium duration cultivars respectively in succession. On many occasions, even single crop of rice could not be grown due to the abnormal delay in receipt of water in the canal. This has resulted in huge production losses of rice, pulse and sugarcane, which are the major crops grown in the Cauvery delta zone.

The recurring water scarcity situation in the delta poses an imminent threat to farming and therefore there is an urgent need to study the existing situation to evolve or shift to alternate strategy to meet the exigency of water scarcity conditions. Farmers adopt certain strategies under water scarcity conditions like direct seeding, alternative cropping, and diversification of enterprises. Migration of households for employment and disposal of asset for meeting their consumption expenditure are also found. Water security is necessary to ensure food and energy security, which are the pre-requisites for sustainable economic development.

Against this background, the present study attempts to examine the adverse effects of water scarcity conditions and to study the drought coping behavior of farm households located in the tail end of Cauvery delta zone.

Objectives

The general objective is to study the socio-economic implications of water scarcity and identify the survival strategies of farm households to evolve appropriate policies for enhancing the income of farmers in the region.

Specific objectives

(i) To examine the impact of water scarcity conditions on land use, cropping pattern, yield, employment and income of farm households;

(ii) To know the extent of instability in paddy yield in the command area;

(iii) To study the consumption pattern of farm households in normal and drought situations;

(iv) To identify the survival strategies adopted by farm households and

(v) To evolve appropriate policies and measures for enhancing the income of farmers.

Hypotheses

In the present study, it is hypothesized that

(i) Water scarcity conditions result in crop failure and farm employment and income gets reduced and

(ii) There exist variations in the consumption pattern of farm households during drought and normal situations.

Scope of the study

The study would identify the impact of drought on farm households in terms of utilization of land, cropping pattern, productivity, and shifts in employment, income and consumption. It would enable the government to have an understanding of the coping strategies followed by farmers and evolve suitable policies and programmes for agricultural diversification in the region. The study would also help research institutes to evolve suitable crop plans for maximizing the returns from farming in the region.

Limitations of the study

The study being area specific involving the collection of both primary and secondary data from farmers and various government departments has its own limitations. The farmers by nature are not in the habit of maintaining records of their own expenses and income. Therefore, the respondents have furnished the required information for the study from their memory. However, efforts were made to minimize the error by cross checking of the data then and there. The study pertains to a particular district and region, and so generalization to other areas must be done with caution.

Organization of the thesis

The thesis has been organized in the following pattern

Chapter I: Introduction

Identifies the problem of research and specifies the objectives, hypothesis, scope and limitation of the study.

Chapter II: Concepts and Review

Concepts used in the present study and reviews of past work done are given.

Chapter III: Design of the study

Specifies the sampling design, method of data collection and tools of analysis used in the conduct of the research and analysis of data.

Chapter IV: Description of study area

Presents the general characteristics with details of infrastructural facilities available in the study area.

Chapter V: Results and Discussion

Results of the study are presented and discussed.

Chapter VI: Summary and Conclusion

A summary of findings of the study is presented and conclusions with policy implications are given.

CHAPTER II
CONCEPTS AND REVIEW

In this chapter, an attempt has been made to review the various concepts and past studies relevant to the present research. The objectives of the study are to analyze the influence of rainfall on crop yields, to know the impact of water scarcity condition on farming and to identify the survival strategies adopted by farm households. Hence, the concepts like water scarcity condition, drought, classification of drought, employment, income, consumption, agricultural diversification and food security are presented. Besides a review of past studies on instability in crop production, influence of rainfall on crop yields, impact of drought and survival strategies of farm households was also undertaken to have a better grasp of the problem and conduct of the study.

2.1 CONCEPTS

2.1.1 Water scarcity

According to the Indian council of Agricultural Research [ICAR] (1977), breaks in monsoon cause drought. These breaks were generally associated with little rainfall lasting from few days to longer period. A prolonged break often resulted in partial or complete crop failure over large area of the country and as a consequence, scarcity conditions or famine occur in such areas.

Koala (1994) defined drought as a sustained and regionally extensive deficiency in precipitation causing a serious hydrological imbalance. Thus water scarcity caused by failure, deficiency or untimelyness of rainfall led to a drought situation. The term drought has been defined differently by various organization and research workers.

In this study, the term water scarcity described as frequent failure of monsoon and no release of Cauvery water resulted in crop failure.

2.1.2 Drought

The National Commission on Agriculture [NCA] (1976) recognized drought as an occasion when rainfall for a week was half of the normal or less, when the

normal rainfall was five mm or more. Agricultural drought was a period of four such consecutive weeks in the period from mid may to mid October or six such consecutive weeks during the rest of the year.

Thornthwaite (1948) described drought as a meteorological situation, when evapotranspiration exceeded precipitation and was the first to use the concept of moisture index to explain the phenomenon.

Holmes (1959) viewed drought as a period of insufficient moisture occurring during certain critical stages of crop growth. He used the concept of soil moisture budgeting and evapotranspiration to study the intensity of drought at different growth stages of crops.

According to Ramdas (1960), drought was a situation when the actual seasonal rainfall was deficient by more than twice the mean deviation.

Palmer (1965) described drought as an interval of time during which actual moisture supply at a given place consistently fall short of climatically expected moisture supply.

Mooley (1984) defined drought as a situation when the rainwater received over the country was less than the tenth per centile of the probability distribution of the annual rainfall.

Ram mohan (1984) defined drought as a period of dryness due to lack of rain and was interpreted in various ways depending on the normal climatic conditions, available water resources, agricultural practices and economic activities of the region.

Khanna (1989) defined drought year as a year when the area affected by moderate or severe drought condition, either individually or together was more than 20 per cent of the total area of the country.

Singh *et al.* (1990) defined hydrological drought as a condition of severe shortage in the surface and ground water, rivers and stream flows.

Batil (1992) viewed drought as a situation when soil moisture and rainfall in a cropping season were inadequate to meet the crop needs.

According to Dubashi (1992), droughts were bound to recur because they were often all a part of climatology. For every seven good seasons, there were at least two or three bad seasons in India.

The term drought has been defined differently by various organizations. For the present study, the term drought referred to water scarcity situation during the crop season, sufficiently prolonged to adversely affect the yield of crops.

2.1.3 Classification of drought

The National Commission on Agriculture (1976) has broadly classified drought into three types as meteorological drought, was a situation when the actual rainfall was significantly less than the climatologically expected rainfall over a wide area. Hydrological drought, if meteorological drought prolonged would be resulted in hydrological drought with severe shortage in surface and ground water and river and stream flows. Agricultural drought, takes place when soil moisture and rainfall were inadequate during growing season causing extreme crop stress and wilt.

Indian Meteorological Department (IMD) considered drought as a deviation of annual rainfall by more than 20 per cent of normal. It classified drought as 'severe' when deviation was more than 60 per cent of normal, 'moderate' when deviation ranged from 19 to 59 per cent and 'scanty' when it was 19 per cent of normal annual rainfall.

Khanna (1989) classified drought as an area receiving less than 75 per cent of the normal rainfall. Further, it was classified as moderate and severe, if the seasonal rainfall deficiency was between 26 to 50 per cent and more than 50 per cent of the normal respectively

Droughts were also classified based on their relevance to the users by Reddy (1999) as follows. Meteorological drought was defined as a condition, where the annual precipitation was less than the normal over an area for prolonged period

say a month, season or year. Atmospheric drought was due to low air humidity, frequently accompanied by hot dry winds. It may occur even under conditions of inadequate soil moisture. Plants growing under favourable soil moisture conditions are usually susceptible to atmospheric drought. Meteorological drought, when prolonged resulted in hydrological drought with depletion of surface water and consequent drying of reservoirs, tanks etc. Agricultural drought was the result of soil moisture stress due to imbalance between available soil moisture and evapotranspiration of a crop.

Sharma (2002) classified drought spells of varying duration based on onset and withdrawal of monsoon as normal onset, but may have drought spells of 8-20 days duration in the middle of the rainy season, late onset of monsoon as early season drought and normal onset of monsoon but early withdrawal of monsoon as late season drought.

2.1.4 Employment

Visaria (1980) considered all those who have worked for at least 10 days or more during the month of interview or season preceding the survey as employed.

Krishnaraj (1981) defined employment on the basis of time criteria. A person was said to be fully employed if he obtained employment for 300 days or more during the reference year.

Jain (1983) viewed that if a person worked atleast for one hour, but less than four hours a day, he would be considered to have employed for half a day. On the contrary, if he had worked for four hours or more during the day he would be considered as employed for the whole day.

Bishnoi (1996) defined employment as a state of being engaged in productive work. It should be continuous and intermittent; with sufficient amount of man-hours or man-days of work rendered and the income accruing from it should be commensurate with the efforts made.

Rajinikanth (2000) defined employment as one that generated income to the employed, yielded output and gave a person the recognition of being engaged in something worthwhile.

Rajni (2002) defined employment as a means for getting income to lead a reasonable level of living. A person was said to be gainfully employed if he / she worked for 300 days in a year during the reference period.

For the present study, employment is defined as number of man-days employed in a year and a person is said to be gainfully employed if he /she worked for 300 days in a year during the study period.

2.1.5 Income

According to Mishra and Gupta (1975) income from farming included income from all enterprises after making deductions for cultivation, maintenance and other expenses, which were paid by the family in cash and kind in raising the various enterprises of the farm.

Satyanarayana and Pandey (1981) defined farm income as income including the value of crops, livestock products, sales of farm assets, receipts received from land, custom services etc.,

Dolan (1983) defined income as the total income actually received by households including both earned and transfer payments.

National Council of Applied Economic Research (NCAER) (1989) defined household income as self-employment income from business, profession and services, salary, agricultural and non-agricultural wages, rents, interest, dividend income and transfer income.

Yasodha (1995) obtained income by deducting all cash expenses incurred for the crop and livestock enterprises, from the gross income earned from those enterprises.

Jeyakumar (1999) conceptualized income as the sum total of income received by all members of the family working in different categories or the same kind of work. The source of income included farm, non-farm and any assistance from government programme.

Rajinikanth (2000) defined household income as the total amount of current receipts by all members of the household during the reference period from wages, agricultural and non-agricultural wages, income from currently operating household industries and business, profession, services, rent, interest, gifts, dividend and bonus.

The present study considers income from farm, non-farm and off-farm sources as the total household income.

2.1.6 Consumption and consumption expenditure

According to the National Council of Applied Economic Research (1979), consumption could include all the quantities purchased, in exchange for money or goods and services or consumption out of homegrown stocks, gifts or loans. Household consumption referred to domestic consumption only with the exclusion of the articles used by households for production process.

Muthukrishnan (1981) considered expenditure on cereals, pulses, oils, spices and condiments, vegetables, milk and milk products, mutton, egg, fish, beef, pork, chicken, fuel and lightning, clothing, education, recreation, medical, house rent, social and religious activities as the components of consumer expenditure.

National Sample Survey (42^{nd} round) (1989) defined household consumption expenditure to include all expenditure incurred by the household on domestic account, including the consumption of homegrown products or transfer receipts like gifts and charities.

Velavan (1992) considered consumption expenditure as the expenditure incurred on food and non-food items. Food items included cereals, pulses, oil, spices and condiments, meat, fish, egg, fresh fruits, processed vegetable products, food products, milk and milk products and other miscellaneous food items. Non-food

items included clothing, rent, fuel and lighting, education, recreation, medical, expenses on travelling and other miscellaneous expenses.

Gopalakrishnan (1993) defined consumption as the expenses on non-durable goods and services used up and the annual cost (depreciation plus interest cost less capital gain if any) of durable goods.

According to Thanmathi (1995) consumption expenditure included the amount spent on food items, housing, clothing, fuel and lighting, services, education, transport, electricity, medical, social and religious classes, house repairs, recreation and taxes. She also included consumption out of own grown produce valued at appropriate rates.

National Sample Survey (54^{th} round) (1999) defined household consumption expenditure as the total of monetary value of consumption of various groups of items, food clothing and miscellaneous goods.

For the present study, household consumption is defined as the total consumption expenditure on food items like cereals, pulses, oils, sugar, vegetables and non-food items like clothing, rent, fuel, recreation, medicines and other expenses.

2.1.7 Price

Acharya and Agarwal (1994) considered the price of the commodity as the value expressed in terms of a standard monetary unit. It thus referred to the want satisfying power of a commodity expressed in terms of money.

Mukherjee and Sampath (1996) viewed price in monetary terms, for which goods and services would be exchanged.

Chinnadurai (1997) defined price as a value of a product or service, both for the buyer, seller and consumer.

Karnati (1997) defined price as the quantity of money that has to be exchanged for one unit of a good or service.

Rajni (2002) defined price, as the amount consumers would pay for getting the ownership of the product.

For the present study, price is defined as the amount of money that the consumers have to pay for the product.

2.1.8 Demand

Mukherjee and Sampath (1996) defined demand as the ability to consume certain quantities at certain prices.

Karnati (1997) viewed demand with reference to price. In his view demand means the units of an article that a person wishes to buy at a given price.

Loganadhan *et al.* (1998) defined demand as the desire from something plus the willingness and ability to pay a certain price in order to possess it.

Rajni (2002) viewed demand as a function of price, income, price of related goods and tastes.

For the present study, demand is considered as a function of price, income, and prices of related goods.

2.1.9 Elasticity of demand

Watson (1982) conceived elasticity of demand as the ratio of relative change in a dependent variable to the relative change in the independent variable.

Sankaran (1991) defined elasticity of demand as the degree of responsiveness of the demand for a commodity to a fall in its price.

Mukherjee and Sampath (1996) defined elasticity of demand as the degree of responsiveness of quantity demanded of a commodity to a change in any of the variables affecting demand viz., price of a commodity, income of the consumers, and price of related goods.

Lokanathan *et al*., (1998) defined elasticity of demand as the proportionate change in quantity demanded in response to a small change in price divided by the proportionate change in price.

For the present study, elasticity of demand is defined as,

$$\text{Elasticity of demand} = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}}$$

where, quantity is a function of price keeping other variables (tastes, income and prices of related goods) constant.

2.1.10 Cross elasticity of demand

According to Watson (1982), cross price elasticity of demand dealt the relationship between the quantities bought of one commodity and the prices of another. The demand for commodity A is a function of price of commodity B, keeping tastes, incomes and commodity A's price equal.

$$e_{AB} = \frac{\text{Per centage change in quantity A}}{\text{Per centage change in price of B}}$$

Koutsoyiannis (1979) defined cross elasticity of demand as the proportionate change in the quantity demanded of X resulting from a proportionate change in the price of Y.

Mukherjee and Sampath (1996) stated cross price elasticity of demand as the responsiveness of demand for a product, to a change in the price of another product.

Karnati (1997) defined cross price elasticity of demand as the degree of responsiveness of demand for a commodity to a change in the price of another product.

According to Lokanathan *et al*. (1998), cross price elasticity of demand measured the responsiveness of per centage change in quantity demanded of one good (x) as a result of change in price of other good (y).

For the present study, cross price elasticity of demand is defined as the responsiveness of per centage change in the quantity demanded of one good, say X, as a result of change in the price of other good Y.

2.1.11 Income elasticity of demand

Sankaran (1991) defined income elasticity of demand as the ratio of proportionate change in the quantity demanded of a commodity to a given proportionate change in the income of the consumer.

Mukherjee and Sampath (1996) defined income elasticity of demand as the responsiveness of the quantity demanded of a commodity or service to a change in his personal income.

Karnati (1997) defined income elasticity of demand as the degree of responsiveness of demand of a person for a particular commodity to a change in his income.

Kalamani (2001) conceptualized income elasticity of demand as the per centage change in demand with respect to per centage change in income.

For the present study, income elasticity of demand is defined as a proportionate change in the quantity demanded, resulting from a proportionate change in income

2.1.12 Food security

Food and Agricultural Organization (FAO) (1981) termed food security as a physical and economic access to food by all people at all times involved in concurrent steps of production and consumption. Later, it enlarged its concept of food security by including three components. (i) Ensuring that all people at all times have both economic and physical access to basic food they need (ii) Ensuring production of adequate food supplies and access to available supplies and (iii) Provision of all factors that have a bearing on capacity of both countries and people to produce or purchase food.

World Bank (1986) slightly modified this concept and indicated that food security meant access by all people at all times to enough food for an active and healthy life and its essential elements were availability of food and the ability to acquire it.

World Food Council (1988) considered food security as a two-fold problem. First food was said to be available, accessible, affordable, when and where needed in sufficient quantity and quality needed and second is an assurance that this state of affairs could reasonably be expected to continue or in other words, that it could be sustained.

According to Maxwell and Frankenberger (1992) food security has been conceptualized as a secure access at all times to sufficient food and the four basic concepts in the definition were (i) sufficiency, (ii) temporal consideration, (iii) access and (iv) security.

Haddad *et al.* (1994) expressed food security as availability of sufficient food at all times for all people in order to ensure an active and healthy life. Sufficient food referred to both quantity and quality needed for good health.

FAO (1996) slightly modified its view on the concept of food security as access by all people to "safe and nutritious food to maintain a healthy and active life".

According to Costa (1997) the concept of food security essentially meant a state of affairs where all people at all times have access to safe and nutritious food to maintain a healthy and active life.

According to World Food Programme (1998) food security would be deemed to exist when all people at all times have the food needed for an active and healthy life. It considered not only food supply issues but also issues of distribution and access as well as vulnerability to risks that would threaten household food security.

International Food Policy Research Institute (IFPRI) (1998) viewed household food security as a concept that would integrate environmental, economic and cultural

factors in a manner that would provide a useful tool for predicting dietary patterns within the household and it would reflect three different dimensions viz. past food supply, current food stocks and future supply of food to meet the needs of all household members adequately.

Swaminathan (2000) considered biological absorption of food as a constituent along with availability and access. In his view, availability was a function of production while access was conditioned by purchasing power and biological absorption has been determined by the availability of safe drinking water, primary health care and environmental hygiene.

Rajni (2002) defined food security as the availability and access to food at all times needed for the household to lead a healthy life.

For the present study, food security is defined as the ability to assure on a long term basis that the food system provide the household access to a timely, reliable and nutritionally adequate supply of food.

2.1.13 Agricultural diversification

Sharma (1994) indicated that the concept of diversification of agriculture demand a move towards industries and services at the macro level and was an integral part of transformation of an economy.

Pandey and Sharma (1995) defined agricultural diversification as a larger crop mix, creating a land use conflict among the various crops and crop groups like food grains and non-food grains especially on the small farms.

Satyasai and Viswanathan (1996) opined that diversification in agriculture, could be broadly defined as producing increased variety of agricultural commodities.

Vyas (1996) defined the concept of agricultural diversification as changes, which were in the nature of shift from one crop to another crop or from one enterprise to another enterprise. There was also another type of diversification, which may express itself as an addition of a complementary enterprise to the main enterprise.

Thus diversification suggested anyone of the following three situations (i) a shift from farm to non farm activities (ii) a shift from less profitable crop to more profitable crop or enterprises (iii) use of resource in diverse but complementary activities.

Singh *et al.,* (1997) viewed farm diversification as a strategy for reaping the gains of complementary relationship or equating substitution and price ratio for competitive products. They also indicated that farm diversification may also be used as a risk precaution to stabilize farm income.

Kebebe *et al*. (1999) defined diversification as a strategy of shift to commercial crops or commodities that could increase income in agriculture and minimize risk due to crop failures and above all could earn foreign exchange.

Ram (1999) defined diversifications as a shift from subsistence farming to commercial farming and /or from low value food or non-food crop to high value food or non food crop, and switch over from local to HYV. He also defined, diversification to include shift from agriculture to animal husbandry, pisciculture, poultry, agro-forestry, horticulture etc., or vertical diversification i.e., shift to non-farm economic activities.

In the views of Sharma *et al.* (2001) diversification of agriculture was considered essential to augment household income and provide employment by using all resources at the disposal of the household.

Rajni (2002) defined agricultural diversification as cultivating more number of crops in a given area during a given period of time, and also allied activities like cattle, goat rearing that could contribute to the income of the household.

For the present study, agricultural diversification has been viewed a shift from one crop to another crop and also shift from farm activities to non-farm activities.

2.2 REVIEW OF LITERATURE

2.2.1 Instability in crop production

Naidu *et al.* (1991) studied the growth and instability of agricultural production in Chitoor district of Andhra Pradesh during the period 1954 to 1986. The author worked out coefficient of variation and coefficient of instability to know the extent of instability in crop production. The results indicated that variations were more in the production of total pulses and sugarcane due to improved technology. In the case of other crops, drought, pest and other technological factors were found to be the major factors causing instability in production.

Ninan and Chandrasekar (1993) made a review of crop performance during 1955 to 1988 for all India and Karnataka using coefficient of variation around trend as a measure of instability. At the all-India level, irrigated crops and areas with access to modern technology dominated the growth process, while in contrast, in the predominantly rainfed Karnataka state, dry crops have registered a higher growth with instability in yields. The author suggested soil and moisture conservation measures, income enhancing crops like fruits and activities like livestock rearing for sustained growth of semi arid regions.

Tripathy and Gowda (1995) studied the sources of variability of food grain production in Orissa. The decomposition analysis showed that increase in the mean yield contributed a large part to increase in average rice production. To achieve self-sufficiency in rice production, policies for increasing productivity of rice should be accorded top priority in agricultural planning.

Jain *et al*. (1996) studied the instability of oil seed production in Madhya Pradesh for a period of 10 years ending 1989-90. The author employed coefficient of variation and Coppock's instability index to study instability. The study revealed that area growth contributed more to production rather than the yield. The author suggested that adequate attention has to be paid to increase the productivity.

Vani and Vyasalu (1996) analyzed the growth, variability and instability in three major cereal crops (rice, ragi and jowar) in Karnataka. Coefficient of variation revealed inter-district variations to be higher in the post green revolution period.

Kalirajan and Shand (1997) employed decomposition of total factor productivity (TFP) for estimating the sources of output growth. TFP was the combined result of technical progress and technical efficiency. The authors decomposed total output growth into three components *viz.*, input growth, technological progress and changes in technical efficiency. The study identified that the contribution of technology to output growth declined substantially particularly from 1988 to 1990.

Nagaraj and Gowda (1997) studied growth and instability of safflower production in Karnataka for 31 years ending 1994-95. The author employed Hazell's (1982) methodology of variance-covariance approach The results of instability analysis revealed that production of safflower in the state was unstable due to interaction between changes in mean yield and area variances. This implied that increase in mean yield resulted in a greater variability in area. An appropriate price policy was suggested for reducing variability in area.

Tripathy and Mishra (1997) employed compound growth rates and decomposition analysis, to estimate growth and instability of ragi production in Orissa for the period 1970-71 to 1989-90. They observed that area was the dominant source of output growth of ragi in the state.

Gopal *et al.* (1998) studied growth and instability of foodgrains in ten agro-climatic zones of India. They employed compound growth rate and trend analysis to bring out the convergence or divergence of growth, as a measure of instability. The results showed that trend in area under foodgrains showed convergence indicating decreasing year-to-year fluctuations in all the sub-regions and consequently entire zone. The primary variance effects of area, yield and their covariance effect were the major contributing factors to variability in production. The yield–area covariance has an overall stabilizing effect on production variance in the zone.

Radha and Prasad (1999) employed coefficient of variation and Coppock's instability index to know the extent of variability and instability in area, production

and yield of crops in Andhra Pradesh. They observed larger variations in area and yield.

Suhag *et al*. (2000) employed decomposition analysis to estimate the source of growth of output in Haryana agriculture for 11 principal crops. They observed 82 per cent increase in foodgrain production to be contributed by yield improvement.

Dashora *et al.* (2001) studied instability of pulses production in Rajasthan for a period of 26 years ending 1992-93. The results indicated that production and productivity exhibited higher variability in cowpea in the state. Fluctuations in crop output can be reduced by use of efficient water management and moisture conservation techniques.

Singh and Chandra (2001) studied growth trend and instability in area, yield and production of foodgrains in Uttar Pradesh. They employed decomposition analysis for finding out the effect of area yield and their interaction in increasing the foodgrain production for the time period (1950-51 to 1999-00). The results of the study indicated that contribution of area to production was more than yield.

Siju and Kombairaju (2001) employed decomposition analysis to study the contribution of area, yield and interaction of area and yield in increasing rice production in Tamil Nadu. The analysis was done for three periods namely pre-green revolution (1949-1965), post green revolution (1966-1998) and the entire period (1949-1998). The results indicated an increasing trend of production and productivity. The decline in area was more than compensated by increase in productivity and hence production registered positive growth during the post green revolution period.

2.2.2 Rainfall behaviour and crop yield

Hazell (1982) decomposed the components of change in the variance of total cereal production in the pre-green revolution period (1952 to 1964) and the post green revolution period (1967-1977) into area and yield variances and intercrop variances within and between states. Yield variability was one of the important source of increase in production instability in all the cereals except jowar and minor millets partly due to the adoption of input intensive modern technologies and partly due to

factors like price variation, highly erratic rainfall patterns and fluctuating supplies of modern farm inputs.

Nadkarni and Deshpande (1982) studied the influence of rainfall on crop yields during 1955-1973 in Karnataka. Rainfall accounted for the regional differences in yield instability. They suggested that apart from rainfall, economic and institutional factors particularly the states and man's ability to cope with droughts, floods and other calamities also contribute to yield variability.

Mahendradev (1987) analyzed growth and instability in foodgrain production in India during 1960 to 1984. Standard deviation for year-to-year changes in production was used as a measure of instability. Rainfall accounted for much of the variations in foodgrain production. In general low rainfall or low irrigated states registered relatively higher magnitude of instability than other states.

Gajja (1987) analyzed the rainfall instability on crop yields to examine the relationship between crop yields and rainfall in Jodhpur district of West Rajasthan for the period 1956-82. Rainfed crops viz., Kharif pulses, bajra and sesamum exhibited higher level of instability and rainfall had significant influence on their yields. The author called for proper soil and moisture conservation techniques for reducing yield instability in arid areas.

Dhawan (1987) made a state wise analysis of instability in irrigated and rainfed segments during 1973-1984. States with lower variability in rainfall or more irrigated acreage recorded lesser variability in yield and vice versa. Also the stability gain in yield following irrigation was found to be more conspicuous in states with low or medium rainfall as compared to high rainfall states. In the absence of irrigation, impact of drought on agricultural output was felt more in low rainfall regions. In high rainfall areas, irrigation aggravated the adverse output impact of a drought. Source-wise, tank irrigated farming was most vulnerable to drought, while tube-wells were quite immune to drought.

Gajanana and Sharma (1990) opined that variation in annual rainfall was random and only the magnitude of instability in rainfall and risk associated with it could be studied.

Chowdhury and Gore (1991) applied curvilinear regression techniques to examine the effects of rainfall, maximum temperature and relative humidity on rice in Bhandara district of Maharashtra. It was observed that during the period of active growth, rainfall was the most important factor and the optimum value was found to be 1000 mm.

Mohandas (1991) analyzed the rainfall data for the period 1956 to 1985 in Kerala. He analyzed the season-wise, district wise, month wise distribution of rainfall and fluctuations in annual rainfall. The analysis revealed that state as a whole experienced a decreasing trend in rainfall. This can also be a reason for the change in cropping pattern in favour of perennial crops. The author suggested the need for creation of additional irrigation facilities to cope up with water scarcity.

Ninan and Chandrasekar (1994) studied the growth and instability of crops in Indian agriculture. They reported that semi-arid regions have greater level of instability in crop yields as compared to humid and temperate regions, which indicate the role of weather in effecting yield uncertainty.

The analysis of rainfall data from 1975-1999 revealed a cyclical pattern (Sivasamy, 2002). The annual and southwest monsoon rainfall were characterized by very high spatial and temporal variations and observed that droughts recur once in five years.

2.2.3 Impact of water scarcity conditions on farm households

Muranjan (1991) examined the impact of 1987-88 drought on economic conditions of cultivators in the severely drought affected Bhandara and Wardha districts of Maharashtra. There was a shift in area under paddy to non-traditional crops like wheat, jowar, gram in Bhandara district and tur, gram, groundnut, sunflower and sesamum in Wardha district. Paddy output per hectare varied from 6 to 50 per cent and for jowar 13 to 47 per cent due to reduction in input use. Contingent

production and employment planning by state government was felt necessary to meet drought situation at various levels in the district.

Bidinger *et al*. (1991) studied the economic, health and nutritional consequences of 1986 and 1987 drought in Dokur village of Maharashtra. The median per capita household income at 1977 prices reduced from Rs 4 to Rs 2 between pre drought year and second drought year with one-forth of households recording negative income and crop area also declined. The producer price of paddy increased by 30 per cent of pre drought year but unemployment rose from 5 to 19 per cent resulting in a fall in nominal wages for women. The authors suggested visible public works programme with reasonable wages, subsidy for coarse cereals, a staple food during drought and provision of protected drinking water supply.

Rangaswamy (1992) found that food production declined by about 49 per cent during 1984 drought against the normal year in Mehindargarh district of Haryana and stressed the need for micro-watershed planning in the drought - prone Southwestern regions of Haryana.

Dhanagare (1992) studied the impact of 1992 drought in Maharashtra. There was a shift in crop pattern and the proportion of crop under irrigated land declined. Systematic long term planning for water resource development was necessary.

Acharya (1992) assessed the effect of 1987-88 droughts in Rajasthan. Crop yields reduced by 94 per cent during kharif season and 17-90 per cent in rabi season, Prices of inputs rose by 13.94 per cent and livestock population reduced by 22 to 33 per cent. The author identified them as first generation effects of droughts. Second generation effects include decline in farm employment by 50 per cent and that of crop income by 43 per cent and consumption level of foodgrains remained the same, but coarse cereals were substituted by wheat.

Rangaswamy (1992) studied the impacts of droughts on rural economy in Rajasthan. The author reported various implications of drought. There was a fall in food output (49 per cent) during 1987-88 (drought year) compared to 1988-99 (good year), reduction in cropped area, kharif season output declined more than the

rabi crops like bajra and gram, as they were largely rainfed. The author suggested various drought relief programmes like supplying of drinking water, nutrition programmes and employment generation schemes to combat drought.

Katyal (1993) examined the impact of 1992 and 1993 kharif drought on agricultural production and employment in the rainfed Ranga Reddy district of Andhra Pradesh. Fertilizer consumption reduced from 35 kg/ha in 1992 to 20 kg/ha in 1993. The expected yield levels in different crops were about 40-67 per cent less than the actual yield levels of normal year. Farmers wanted increased food rations through public distribution system, supply of farm inputs and fodder and credit facilities to take up dairying and deepening of wells to build resilience against drought occurrence.

Ashton and Abdulla (1996) studied the physical and financial impact of 1994-95 droughts on Australian dairy farmers and also discussed the impact of drought management strategies on family life styles. An estimated 5500 Australian dairy farmers were directly affected by the drought while 5100 were indirectly affected through higher fodder prices. Approximately 28 per cent of dairy farmers experienced a loss in milk production as a result of drought.

Singh (1996) found the severe drought of 1987-88 to cause large-scale disruption in economic activities resulting in a decline in employment and an increase in seasonal and temporary migration. Data collected from 320 rural families indicated that the unemployment rate was about 39 per cent. Relief operations of the government were moderately successful in mitigating the misery of the affected population. The author argued that the existence of large-scale unemployment called for multi-pronged efforts towards creating demand for labour both on and off the farm and members to enhance the productivity of labour.

Sakurai and Reardon (1997) estimated the demand for formal drought insurance using farm household data. The study revealed that effective demand was found in all zones, which implied that there was an adequacy of household current self-insurance strategies. There was much heterogeneity in the strategies to self-insure even within zones. The expectation of public food aid decreased demand for

drought insurance, which suggests that food aid was causing moral hazard. Household with large livestock holding can reduce the size of herd by substituting drought insurance for livestock holding.

Steen (1998) attempted to report some preliminary results of a research project on sustainable agricultural management of scarce natural resources in the Cauvery river basin. The author outlines a dialectical relationship between conflicts and development to be rooted in the political economy of the region. Development in the form of introduction of new farming methods, generates increased use of natural resource and competing claims on the resources led to their over exploitation and conflicts.

Bokil (2000) observed that the drought situation in Rajasthan has resulted in migration of nuclear families in search of employment and the dependents especially the children were affected.

Rajesh (2000) observed that due to drought, foodgrains were not available to the people and caused debt and poverty in Rajasthan.

Umamaheswari *et al.* (2001) studied the impact of drought on farm households in a drought prone district in Tamil Nadu. The study reported changes in cropping pattern, steep drop in farm production, and income level and consumption pattern of farm households due to drought.

Sowmya and Kerbart (2004) studied the impact of drought on livelihoods in rural Rajasthan. They observed that more than 80 per cent of households to eat less in drought year than normal year. This led to reduced calorie intake, skipped meals and affected the children in terms of health, education etc.

2.2.4 Survival strategies of farm households

Jodha (1975) studied drought in five drought prone areas of India. He reported crop and livestock income contributed only 5 to 16 per cent total sustenance income. It was compensated by borrowings and public relief, by 44 to 73 per cent and 22 to

56 per cent respectively. Sale of assets, migration remittance, attached labour etc., were the other source of sustenance income.

Jodha (1991) categorized the survival strategies adopted by farmers against drought and uncertainties in dry tropical regions into (i) folk agronomy-cropping and agronomic measures like crop rotation, growing crops with high stalk grain ratio, adjusting planting etc., (ii) ethno-engineering- traditional soil conservation practices like tillage, mulching, installation of irrigation structure etc., (iii) indigenous agro-forestry-complementary use of annuals and perennials (iv) occupational diversity-diversity of activities and practices having non-covariate flows of output or income and input requirement, example: mixed farming (v) self-provisioning systems-high dependence on own resources for production and consumption flexible resource use on-farm storage and recycling (vi) collective sustenance-mutual self help dependence on common property resources, migration etc.,

Teklu (1992) identified the production, migration, asset, income and consumption paths through which households in general pass through to overcome seasonal and periodic production and income shortfalls. The sequential pattern of adjustments varied among different categories of households. Depending on the intensity and frequency of the crisis adjustments takes place within and or between paths. The cost of adjustment increases as farmers move from production path down to consumption path over time.

Karanth (1993) studied the survival strategies of farmers in the drought prone Chitradurga district of Karnataka. Small and marginal farmers resorted to hard options such as foregoing of assets like livestock, migration in search of work and fodder, borrowings, working as wage labourers, entering bonded labour service etc., reduction in use of hired labour, longer hours of grazing, use of non-conventional food and fodder, and deferment of social and religious functions were the common strategies adopted by large farmers. The author called them as “frugal strategies”.

Prasad (1998) studied famines and drought and survival strategies in Anantapur district of Andhra Pradesh during 1957-58 to 1990-91. The survival strategies adopted by farmers were seasonal migrations, innovations in cropping

patterns, exchange of labour on a co-operative basis, adjusting or reducing food intakes, sale of assets, etc.,

Kinsey *et al.* (1998) studied drought coping mechanism of rural households in Zimbabwe during 1983-96. The authors used panel data to investigate the response of households to drought risk. The country experienced four major droughts (1982-84, 1986-87, 1991-92, 1994-95). The main private coping mechanism is the sale of cattle. Households most at risk during droughts were those without livestock.

Mehta (2000) diagnosed drought in Kutch of Gujarat. State interventions have not only failed to mitigate water scarcity but also exacerbated some problems in various areas and they failed to design strategies suited to the region.

Indira (2001) studied the vicious cycle of drought and scarcity of works. The author observed the frequency and severity of drought to have increased in India. An efficient information system has to be provided on early sign of drought to assess the spread and extent of scarcity.

Shah (2001) observed water scarcity induced migration in Gujarat. The distress migration was resorted by the poor in less favored regions, more so in areas that faced chronic water scarcity.

Umamaheswari *et al.* (2001) reported migration, asset disposal, borrowing and sale of livestock were the major survival strategies adopted by farmer households. The authors suggested soil moisture monitoring and watershed approach for management of drought prone areas.

Sharma (2002) studied drought management in central India. The author identified survival strategies like reduced consumption, postponement of social arrangement such as marriages and other functions, migration to better areas with livestock, or sale of livestock, consumption loans and sale of assets like gold ornaments to be common and some of the farmers resorted to stocking of foodgrains and fodder to tide over the crisis.

2.2.5 Agricultural Diversification

Mani and Varadarajan (1995) analyzed the diversification of farms. The results of the study indicated that it was large farms that diversified the most and small farms followed next. The diversification had helped farmer to reduce risk in farm business, but not for increasing farm income or reducing labour use.

Giri and Gandopandhyay (1995) discussed the factors determining farm diversification in West Bengal. The results revealed that for diversifying their farms, farmers not only adopted multiple crops on the same land, but also adopted various non-crop enterprises like dairy, poultry, fishery, mango, banana, papaya, and vegetables. The socio-economic variables like the size of operational holding, size of family, proximity to market; extent of non-farm income were related to the adoption of various non-crop enterprises. It was also found that the size of dairy unit was independent of the size of operational holding but depended more on the availability of non-farm income.

Unni (1996) viewed diversification of economic activities and participation in non-agricultural employment from the perspective of an individual worker in a rural household. He revealed that about 75 per cent of the households indicated diversification of their income portfolios at the household level. He concluded that chances of diversification into more than one economic activity were higher among agricultural households.

Satyasai and Viswanathan (1996) employed Herfindahl index to study the relationship between diversification and food security. The results revealed that loss of area share of foodgrains (cereals and pulses) was compensated by gain in area share of non-foodgrain crops (oilseeds, fruits and vegetables). More calories were coming from non-foodgrain items, which indicated the improvement in the quality of food security.

Singh *et al.* (1996) studied the trends in diversification of agriculture in Punjab. The results indicated that Punjab agriculture was gradually specializing towards cereals and diversifying towards secondary and tertiary activities. At the micro-level, the study indicated that diversification was affected by farm size,

distance from the market and assets per hectare and inversely affected by family labour.

Vyas (1996) found that, the farmers pursued dairying as a complementary enterprise to crop production rather than as a specialized activity in most parts of the country. The factors that determine the extent of diversification were markets, price response, market infrastructure, institutional arrangements, agronomic conditions, technology and public interventions

Jha (1997) analyzed the effects of agricultural diversification on food security and poverty in Uttar Pradesh. The study analyzed the possibilities of raising farm income, employment and food security through diversification by adopting the recommended levels of technology with adequate facilities. The crop plus dairy enterprise was evaluated for group I farmers. Under optimal conditions of existing technology for group I, the income was above poverty line while that of group II farmers remained below poverty line. The results indicated that credit and technology were very essential to raise the income of rural poor.

Dangot and Patil (1998) examined the potential for increasing farm income in dry farming areas through diversification. Linear programming technique was used for obtaining optimal farm plans, one with the existing constraints and another by removing the constraint of capital. The results indicated that there was increase in the gross area in the optimal plan. The results of diversification indicated income increase to be high in the optimal plan.

Jawahar and Chowdary (1999) studied crop diversification in North Bihar. The general characteristics of the study had shown that diversification was not to the level, was less than 10 per cent of cropped area under non-foodgrains production. The small and marginal farmers followed 12 different crop rotations as compared to only five by the larger group. The results indicated that smaller category of farms had put large proportion of their operational area under non-food crops.

Kebebe *et al.* (1999) analyzed empirically the diversification of agriculture in Haryana. Among the crop groups analyzed for the study, cereals, commercial crops,

vegetable and fruits were found to be more diversified as compared to pulses and oilseeds. Diversification in vegetables and fruits could be accounted for the changing consumption pattern in urban and rural areas. The number of regulated markets augments diversification while proportion of irrigated area to total cropped area, number of tractors and fertilizer consumption affected diversification adversely.

Ram (1999) found an over all departure from cereals towards oilseeds, pulses and vegetables in Orissa state. He concluded that crop diversification was more in the irrigated rabi season.

Gajja *et al.* (2002) studied crop diversification in arid zone of Rajasthan by employing an index of maximum, Herfindahl, Entropy index and Modified entropy index. The linear regression equation models were used to identify the factors affecting crop diversification based on time series and cross section data. The results indicated that crop diversification was towards "perfect diversification" due to the adoption of number of crops under rainfed situation with the assumption that due to failure or delay in monsoon any one of the crop may give some returns as well as some fodder for livestock.

2.2.6 Food Security Index

According to Haddad *et al.* (1994) traditional indicators of food and nutrition security such as calorie adequacy and anthropometric criteria were difficult to be incorporated into ongoing monitoring and evaluation systems. They developed a conceptual framework to identify and evaluate alternative indicators of food and nutritional security. The results of the empirical analysis showed that relatively simple indication would perform well in locating food and nutritional security.

Gurkan (1995) studied the importance of land and labour productivity in the food sector to ensure household food security. His study also testified the need for general economic and social development to encourage higher productivity and improved food security. He also used aggregate food security index, which incorporates the availability and stability of food supplies and access to them.

Maxwell (1996) briefly reviewed the conceptual and methodological literature on food security measurement and described the method for distinguishing and measuring short-term food insecurity at the household level and discussed ways of generalizing the method. The method developed enumerated the frequency and severity of strategies relied only upon households when faced with short-term insufficiency of food. He also developed cumulative food security index based on the short-term strategies and found that farmers were food secured in dry seasons than in rainy seasons. This method goes beyond the more commonly used measures of calorie consumption to incorporate vulnerability elements of food security as well as the deliberate actions of household decision makers when faced with food insufficiency.

Panth (1997) made an attempt to highlight the issues and strategies of poor households of rural Karnataka for achieving food security. He observed that households had an in-built social network within the rural system that would act as a safety net for maintaining food security. He found wages in kind, borrowings in kind, soft loans, low price of foodgrains, barter system and alms were some of the networks for maintaining food security. Finally he concluded that the social networks would function better in the irrigated areas than in the rainfed areas.

In the study on food poverty and consumption among landless labour households, Rajuladevi (2001) measured the food intake of landless agricultural labour households to find out the variation between slack and lean seasons, in wet and dry villages of Erode district and the findings revealed that majority of sample households survived on cereals and had only one main meal per day and that the landless labourers lived in destitution.

Kalamani (2002) studied the food security situation of farmers in different production environments of Namakkal district in Tamilnadu state. The author employed cumulative food security index to study the food security situation of farm households. The study revealed that farmers in irrigated blocks were more food secured than their counterparts in dry blocks.

Rajni (2002) studied the food security situation of households under different levels of farm diversification in Erode district of Tamilnadu. The author employed cumulative food security index and it was found to be 69.12, 65.29, 72.90 and 61.51 in case of irrigated, dry, more diversified and less diversified farms respectively. Thus farmers in the more diversified region had a higher cumulative food security index.

2.2.7 Almost Ideal Demand System (AIDS)

Kailasam (1991) estimated demand for various food and non-food items of rural and urban households in western Tamilnadu using AIDS model. The estimated demand system suggested that demand for vegetables, milk and milk products, were elastic and responsive for the low-income group people while demand for clothing was elastic for high-income group. The findings of the study led him to conclude that price stabilization of key food and non- food items and providing more employment were essential to improve the standard of living of the people.

Mdafri and Brorsen (1993) estimated demand elasticities for beef, mutton, poultry and fish in Morocco using AIDS. They recognized that mutton was a luxury good reflecting Moroccan's preference for mutton.

Ahmed and Shams (1994) attempted to estimate a complete demand system for rural Bangladesh, applying the AIDS. The estimates of demand parameters were based on primary data from the rural household survey conducted by IFPRI during 1991-92. The results revealed that the rural households in general were highly responsive to changes in income in adjusting their consumption patterns. Demand for commodities was quite responsive to changes in their own prices with the exception of salt. The estimates of cross price elasticities indicated that substitution effects were strong and therefore had important implications for price policies. They concluded that steady growth in production through sustainable agricultural development process would help in price stabilization thereby meeting effective demand of people.

Fan *et al*. (1994) estimated various demand parameters by using AIDS model. The results showed that all the important commodities including rice, wheat, coarse grains, vegetables, alcohol, and tobacco had positive expenditure elasticity. Rice,

wheat and coarse grains were found to be necessities while vegetables, alcohol and tobacco had positive expenditure elasticity. Expenditure elasticity for rice, coarse grains and tobacco were found to be declining but those of wheat, meat, vegetables and alcohol were otherwise. Therefore they opined that China must continue to increase its production by a greater rate in future in order to avoid food shortage.

Durga and Murthy (1995) attempted to make demand projections of six broad commodity groups, separately for rural and urban areas of India using AIDS. Demand projections were made under two alternative income growth scenarios for the immediate post sample period from 1988-89 to 1992-93. They predicted that there would be sizeable decline in the per capita monthly consumption of cereals in urban India, thereby raising serious nutritional concerns in the years to come.

Balcombe and Davis (1996) applied AIDS for analyzing the consumption pattern in Bulgaria. They argued that the conventional estimation of the AIDS should be done within the framework of contemporary time series methodology. The results of the AIDS were consistent with both theory and casual observations of consumer behavior in Bulgaria.

Molina (1996) analyzed the food demand in Spain for the period of 1984-1989 for estimating the AIDS with annual food expenditure divided into six categories. The results showed that own price elasticities were negative for all food items, exhibiting inelastic nature. Milk and eggs had highest own-price elasticity in absolute terms. On the contrary, bread, cereals and fish were insensitive to changes in their own price; their cross price effects were low but with sustainability prevailing. He inferred from his study that bread and cereals, meat, fish, milk, and eggs were necessities whereas vegetables, fruits and other foods were luxuries.

Andavani and Tilley (1997) estimated demand for various fruits in Indonesia using AIDS. The expenditure elasticities for different fruits like apple, oranges, grapes and other fruits were estimated to be between 1.01 and 1.21. The findings led them to conclude that all fruits were competitive in nature with the exception of vegetables.

Han and Wahl (1998) applied AIDS system to estimate rural household demand in China with special emphasis on changes in demand for fruits and vegetables across different income groups. The own-price elasticity for food was found to be more elastic than that for clothing, housing, durable goods, and other items. Within the food group, price elasticities ranged from –1.042 to –0.019. Grain, with an expenditure elasticity of almost unity, was found to be an important non-stable food relative to fruits. Lower value vegetables were the most price elastic in the vegetable group. Fruits were more price elastic than vegetables with grapes being the most price elastic. They finally concluded that different income groups shared a common demand function.

Rajinikanth (2000) used AIDS model to estimate the demand for the food items in the cases of low, middle and high-income groups. The result of the study revealed that the cross price elasticities for most of the products were negative indicating that they are gross complements and vegetables were found to be income inelastic in nature.

CHAPTER III
DESIGN OF THE STUDY

The methodology used for the conduct of the study is presented in this chapter. The chapter focuses on the sampling design, sources of data, data collection methods, analytical tools and techniques used in the study.

3.1 Sampling design

3.1.1 Choice of the study area

The overall objective of the study is to analyze the impact of water scarcity conditions on farming and to identify the survival strategies of selected farm households in the tail end of Cauvery delta zone. Nagapattinam district of Tamil Nadu and Karaikal region of U.T of Pondicherry are located in the tail end of the zone, and hence were selected for the study.

3.1.2 Selection of blocks

Nagapattinam district encompasses seven taluks, which include eleven blocks. Sembanarkoil block has a larger percentage of area under paddy to gross cropped area among the eleven blocks and has been chosen for the study. Sembanarkoil block has 57 villages, out of which nine villages with a larger area under paddy and having canal as the major source of irrigation were chosen. From each of the chosen villages ten farm households were selected at random for the detailed study. Karaikal region has six communes, out of which Thirunallar commune was purposely chosen owing to the larger area under paddy. From this commune, three villages with larger paddy area were purposively chosen. From each of the three villages 10 farm households were selected randomly. The ultimate sample size was 120. Details are presented in Table 1.

Table 1. Block wise distribution of selected sample farm households

Sl. No	District / region	Block / commune	Villages selected	Sample farm households (no)
1.	Nagapattinam district	Sembanarkoil block	Thiruvidaikazhi	10
			Thiruvillaiyattam	10
			Mathur	10
			Thiruchampalli	10
			Peramboor	10
			Mamakudy	10
			Thillaiyadi	10
			Thirukkadaiyur	10
			Eravancherry	10
2.	Karaikal region	Thirunallar commune	Ambagarathur	10
			Nallezhundur	10
			Sethur	10
			Total	**120**

3.2 Method of data collection

To address the proposed objectives of the study, data were collected from both the primary and secondary sources. Sources of secondary data included offices of Assistant Director of Statistics, Assistant Director of Agriculture, Joint Director of Agriculture, Block Development office and Village Administrative Officers of the selected villages in Nagapattinam district and Karaikal region.

Primary data on age, education, household size, land use pattern, cropping pattern, yield, cost of cultivation, employment, income and expenditure pattern of households were collected through a well structured and pre-tested interview schedule by survey method. To know the impact of drought, similar data were colleted for the normal year also by recall. The respondents in general were not in the habit of keeping records and so the data provided were mainly from their memory. Hence, cross-verification of data was done then and there to ascertain the reliability, adequacy and consistency of the data collected.

The schedule covered detailed information pertaining to family, household income, asset position, land and livestock particulars, details about cropping patterns, cost of cultivation, returns realized from crops and employment. Besides, information on consumption expenditure on food and non-food items was included. An opinion survey was also conducted to identify the survival strategies adopted by households to cope with water scarcity situations and particularly to overcome food shortages

3.3 Period of study

The data collection was undertaken during the months of May and June 2004. Data were collected from the sample respondents for the drought year 2003-2004 to study the farm level consequences of drought. For the purpose of comparative analysis between drought and non-drought years, data were collected from the respondents for the normal year 2000-2001 also. So the reference years for the study were 2000-01 (normal year) and 2003-04 (drought year).

3.4 Tools of analysis

3.4.1 Percentage analysis

Simple percentages and averages were worked out to interpret the data related to agro-climatic conditions, land utilization pattern, irrigation and cropping pattern, employment pattern and adoption of various survival strategies in the study area and also to bring out the general characteristics of the sample respondents.

3.4.2 Instability in crop production

The principal crops exhibit wide fluctuation in production. The fluctuations in crop production adversely effect the employment and income distribution and ultimately hamper individual and societal welfare. Hence, an analysis of fluctuations in crop output and area are necessary to know the impact of water scarcity conditions on farming.

3.4.2.1 Instability in area

The degree of instability in paddy area was measured using co-efficient of variation by the formula

Co-efficient of variation (CV) = $\frac{\sigma}{X}$ x 100

Where, σ = Standard deviation

X = Arithmetic mean

3.4.2.2 Instability in yield

Co-efficient of variation adjusted for trend, probability of crop failure, crop-loss ratio and distribution of low yield observations over time (temporal instability) were worked out to study the nature and magnitude of instability in paddy yield during 1972-73 to 2001-02.

3.4.2.2.1. Co-efficient of Variation adjusted for trend (CV_t)

A linear trend equation of the following form

$$y = a + bt$$

was fitted to the time series data (30 years) on area, production and yield of paddy crop and was estimated by Ordinary Least Square (OLS) method. Whenever trend was significant, CV was multiplied by the square root of the unexplained portion of the variation in the trend equation. The appropriateness of CV_t over CV was suggested by Nadkarni (1971). Gajanana and Sharma (1990) applied instability index developed by Cuddy and Della (1978) to take care of the trend component in time series data in examining instability of crop and livestock yield. The index is given by

$$\text{Index of instability } CV_t = CV \sqrt{1 - R^2}$$

Where,

CV = Co-efficient of variation

CV_t = Co-efficient of variation trend

R^2 = Co-efficient of multiple determination

3.4.2.2.2 Probability of Crop Failure (PCF)

"Crop failure" was taken to mean all those cases, where the actual crop production was less than 10 percent below the trend (linear estimate for respective years). The probability of crop failure is the percentage of years of crop failure (thus defined) to the total number of years.

3.4.2.2.3 Crop-Loss Ratio (CLR)

The probability of crop failure by itself does not indicate the magnitude of crop loss and so crop-loss ratio was used. Giving an allowance of 10 percent below the trend estimate for the respective years as tolerable level, the sum of negative deviation below this level is expressed as a percent of the sum of actual yield for the whole period to arrive at this ratio.

$$CLR = \frac{\Sigma \text{ (Negative deviation below 10 percent of } \hat{y})}{\Sigma \text{ (Actual yield)}}$$

3.4.2.2.4 Temporal instability

Instability over time was studied in terms of the distribution of below normal yield of a crop. Temporal instability was expressed as the number of years with below normal yield in succession. The average yield for the 30-year period ending 2001-02 was taken as the normal yield for a crop.

3.4.3 Rainfall behaviour and instability in yield

A review of past studies on instability in agricultural production revealed that the following factors affect the instability in crop yields. They were availability of irrigation, extent of adoption of technology, adequacy of infrastructural facilities, variability in rainfall, prices of factors and products, availability of inputs and biological factors. In the present study the influence of rainfall during individual months of crop season, deviation of rainfall received from the normal rainfall of the locality and proportion of irrigated area to the total area under the crop were considered due to paucity of time-series data on other variables. The significance of each of these variables on yield were studied to find out their impact on yield and a linear function of the following was specified.

$$Y = b_o + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_{6+} e$$

Where,

Y = Detrended crop yields in kg per ha

X_1 = crop season rainfall in mm

X_2 = Index of seasonal deviation in rainfall from the normal rainfall during the

respective crop season.

X_3 = proportion of irrigated area to total area under the crop (percent)

X_4 = volume of water release in canal (tmc)

X_5* = August temperature for I season and December temperature for II season

X_6 *= wind speed during august and December for I and II season crop respectively

b_o to b_6 = parameters to be estimated

e = Stochastic error term

[* August and December months coincide with flowering stage during I and II seasons respectively which is a critical phase in crop growth.]

The index of seasonal deviation in rainfall was defined as

$$\sqrt{\sum X_i^2 Y_i / n^2 x100}$$

Where,

X_i = Deviation of rainfall in month 'i' from the normal rainfall in month 'i'

Y_i = Normal percentage share of month 'i' in the total rainfall during the crop season for which the index is arrived.

i = Respective months of the period for which the index is derived and

n = Duration of crop season in months.

The index was like a weighted standard deviation the weights being the normal percentage share of individual months in normal rainfall during the crop season.

The index would take the value of zero, if during the concerned year's rainfall in every month was the same as the normal for respective months. It considered both the seasonal total and its variation in a single equation.

3.4.4 Crop diversification

Diversification is an integral part of the process of structural transformation of an economy. Thus diversification could suggest any one, or all, of the three situations; (a) a shift from farm to non farm activities (b) a shift from less profitable crop or enterprise to more profitable crop and (c) use of resources in diversified but

complementary activities. In essence, diversification becomes an essential strategy that can increase income and minimize risks due to crop failures.

There are five measures of diversification indices in the empirical analysis. Herfindahl Index, Ogive Index, Entropy Index, Modified Entropy Index and composite Entropy Index were worked out by Shiyani and Pandya (1996) for a spacio-temporal analysis of Gujarat agriculture. In the present study Herfindahl Index was used to measure the extent of crop diversification in the study area.

The index of diversification was measured in terms of deviation of Herfindahl index from unity. Herfindahl index was computed by taking the sum of square of each crop in the total cropped area. It was bounded by 0 (total diversification) and 1 (total specialization). The index takes a value one when there is complete specialization and approaches zero as 'n' gets large i.e., if diversification is perfect.

$$\text{Herfindahl Index } (H.I) = \sum_{i=1}^{n} P_i^{\,2}$$

Where,

n = Total number of crops

P_i = Average proportion of i^{th} crop in the total cropped area

However, the major limitation of the index is that it cannot assume the theoretical minimum i.e. zero for smaller values of n (number of activities).

3.4.5 Food Security Index

Economists have suggested a variety of indicators that can indirectly be used as predictors for food insecurity at the household level like asset ownership, household size and dependency ratio (Haddad *et al*., 1994). An alternative has been to analyze based on strategies adopted for dealing with insufficiency of food at the household level as a direct indicator. Based on the strategies, Food security index have been derived for predicting the food security situation of the household (Maxwell, 1996).

A range of short-term coping mechanisms when there is food shortage in the household by the person primarily responsible for the preparation and provision of

food were identified. Subsequently various strategies identified were assigned an ordinal rank by the respondents according to his perceived severity. Finally, a relative frequency scale was developed so that the higher the number on the scale the less frequently a strategy had to be used (indicating a higher level of food security).

In the present study, six major short–term, food based coping strategies were identified and are listed below. The food security index was constructed based on how the strategies were ranked by the respondents from least severe to most severe.

(i) Eating foods that are less preferred

Although respondents in all income groups reported long-term trends towards eating foods that were less preferred as a means of adapting to lower real income, in a squeeze there was almost always an even less preferred and less expensive food to eat that was roughly comparable, at least in terms of energy.

(ii) Limiting portion size

Cutting back the amount of food that each person in the household gets was the second most common coping strategy, and in terms of severity, it is roughly equivalent to eating foods that are less preferred.

(iii) Borrowing food or money to buy food

Borrowing either food or money was a commonly mentioned practice. Relatives and local merchants extended short-term credit to the farmers for buying food, which lead to indebtedness.

(iv) Maternal buffering

Maternal buffering is the practice of a mother deliberately limiting her own intake in order to ensure that children usually recently weaned toddlers, get enough to eat.

(v) Skipping meals

Eating only one or two meals per day was commonly practiced, particularly by some of the respondents during the time of food shortage.

(vi) Skipping eating for whole days

A more severe means of dealing with food insufficiency was going whole day without eating anything during certain times of the year by lowest income groups.

The strategies were then presented in the order of less severe, severe and most severe one. Frequency scoring was given to each strategy based on the number of times per month that were resorted by the respondents. A simple scale of 1-4 was developed for the frequency of each individual strategy and multiplied by the weighting factor based on the ordinal ranking assigned by the sample respondents. Thus, a discrete score for each strategy was obtained which when added together made up a cumulative food security index. A higher value of cumulative food security index indicated a higher level of household food security

3.4.6 Almost Ideal Demand System

In order to meet the objectives of the present study, a flexible and well-suited demand model is required. There are quite a number of models to describe the consumer expenditure. Not all models are well suited to explain the household budget; cross-section data and some of them are overly restrictive. The Almost Ideal Demand System (AIDS) proposed by Deaton and Muellbauer (1980) suffers from neither of these drawbacks. The advantages of their system are: (i) it gives an arbitrary first order approximation to any demand system. (ii) it satisfies the axioms of choice exactly. (iii) it aggregates perfectly over consumers. (iv) it has a functional form, which is consistent with the household budget data (v) it is simple to estimate in its linear expenditure form and (vi) It can be used to test homogeneity and symmetry conditions.

Moreover the AIDS, in addition to the above desirable properties, does not impose the severe substitution limitations implied by additive demand models such as the Linear Expenditure System (LES). Hence, AIDS was preferred over the other approaches for the present study. The model was used by many researchers for their consumption studies. The model expresses the i^{th} budget share Wi, as a function of logarithm of total expenditure log Y.

$$Wi = A_i + B_i \log Y \qquad (1)$$

Wi = Expenditure share of good i and

Y = Total expenditure

Where, A_i and B_i are the parameters of the i^{th} good.

This model was further extended by Deaton and Muellbauer (1980) to include the effect of prices. The resultant demand system for the AIDS was derived by using duality concepts from a particular cost function, defined as the minimum expenditure necessary to attain a specific level of utility at given prices. Considering the following general cost function,

$$\log C(U,P) = (1-U) \log A(P) + U \log B(P) \quad (2)$$

where,

$$\log A(P) = a_o + \sum_K a_k \log P_k + \tfrac{1}{2} \sum_K \sum_j g_{kj} \log P_k \log P_j \quad (3)$$

$$\log B(P) = \log A(P) + B_o \prod_K P_k B_k \quad (4)$$

C (U,P) = Cost function for utility "U" and prices "P"

M(U,P) = Minimum expenditure function at utility level "U" and prices "P"

C(U,P) = M(U,P) = Y

From equation (2)

$$\log C(U,P) = \log A(P) - U \log A(P) + U \log B(P)$$
$$= \log A(P) + U [\log B(P) - \log A(P)]$$

Using equation (4), we get

$$\log C(U,P) = \log A(P) + UB_o \prod_K P_k B_k \quad (5)$$

That is,

$$\log C(U,P) = a_o + \sum a_k \log P_k + \tfrac{1}{2} \sum \sum g_{kj} \log P_k \log P_j + UB_o \prod P_k B_k \quad (6)$$

K K J K

And applying Shepard's Lemma, which is by differentiating equation (6) with respect to prices, compensated demand functions are obtained. Mathematically the Shepard's Lemma is

$$\frac{\partial C(U, P)}{\partial P_i} = q_i(U,P)$$

i.e., $$\frac{\partial C(U, P)}{\partial P_i} = q_i \qquad (7)$$

By multiplying both sides of (7) by $\frac{P_i}{C(U, P)}$

Equation (7) becomes

$$\frac{P_i}{C(U, P)} \cdot \frac{\partial C(U, P)}{\partial P_i} = \frac{P_i q_i}{C(U,P)}$$

i.e., $$\frac{\partial C \log (U, P)}{\partial \log P_i} = \frac{P_i q_i}{C(U, P)}$$

i.e., $$\frac{\partial C \log (U, P)}{\partial \log P_i} = W_i(U, P) = W_i \qquad (8)$$

where W_i = expenditure share of the i^{th} good, differentiating (6) partially with respect to logarithm of prices we get,

i.e., $$\frac{\partial C \log (U, P)}{\partial \log P_i} = a_i + \tfrac{1}{2} \sum_j g_{ij} \log P_j + B_i U B_o P_k B_k$$

from (8)

$$W_i = a_i + \tfrac{1}{2} \sum_j g_{ij} \log P_j + B_i U B_o \pi_k P_k B_k \qquad (9)$$

Substituting (5) in (6) then by solving for U in terms of P and Y, we get,

$$\log Y = a_o + \sum_K a_k \log P_k + \tfrac{1}{2} \sum_K \sum_J g_{kj} \log P_k \log P_j + U B_o \pi_K P_k B_k$$

$$U B_o \pi_k P_k B_k = \log Y - \left(a_o + \sum_k a_k \log P_k + \tfrac{1}{2} \sum_k \sum_j g_{kj} \log P_k \log P_j\right) \qquad (10)$$

Substituting equation (10) in (9), we get

$$W_i = a_{i+} \tfrac{1}{2} \sum_j g_{ij} \log P_j + \log Y - (a_o + \sum_k a_k \log P_k + \tfrac{1}{2} \sum_k \sum_j g_{kj} \log P_k \log P_j) \quad (11)$$

Then AIDS in the budget share form is,

$$W_i = a_{i+} \tfrac{1}{2} \sum_j g_{ij} \log P_j + \log Y - \log P$$

$$W_i = a_{i+} \tfrac{1}{2} \sum g_{ij} \log P_j + \log (Y/P) \quad (12)$$

for i = 1,2,3…n

where, P is a price index defined in terms of individual prices by

$$\log P = a_o + \sum_k a_k \log P_k + \tfrac{1}{2} \sum_k \sum_j g_{kj} \log P_k \log P_j \quad (13)$$

The adding up restrictions imply

$$\sum_i a_i = 1, \sum_i g_{ij} = 0, \sum_i B_i = 0$$

$$\sum_i g_{ij} = 0, \text{ Homogeneity}$$

$$g_{ij} = g_{ji} = \textit{symmetry}$$

These constraints ensure that the system satisfied adding up, homogeneity in prices and income and Slutsky symmetry conditions, where a_i, B_i, g_{ij} (i, j = 1…n) are parameters.

The price formulation (13) makes the demand system (12) a non-linear system of equations for estimation requiring maximum likelihood techniques. The large number of parameters which need to be estimated, in addition to the co-linearity frequently found among prices often results in computational problems, particularly if the sample size in group is not very large. Due to such problems, the maximum likelihood estimation procedure did not converge. The AIDS presented in equation (12) does not incorporate family size explicitly. To include family size, Ray (1980) used the household utility function and replaced 'P' by a normalized price 'mp' where 'm' denotes family size. Hence in the present study, family size "m" as a deflator for total expenditure is used.

$$W_i = a_i + B_i \log (Y / mp^k) + \sum_j g_{ij} \log(P_{jm})$$

$$W_i = a_i + B_i \log (y / p^k) + \sum_j g_{ij} \log P_j + \theta \log m \quad (14)$$

Where, y = (Y/m) is per capita household expenditure and g_{ij}, θ ($=\sum_i^m g_{ij}$) effect of prices and family size respectively.

Elasticity

The demand elasticities corresponding to the linear version of the AIDS represented by equation (14) are,

The expenditure elasticity of i^{th} commodity,

$$e_i = 1 + B_i / W_i$$

The own price elasticity of i^h commodity,

$$e_{ii} = (g_{ii} - B_i W_i)\ W_i - 1$$

The cross price elasticity of i^h commodity with respect to j^{th} price,

$$e_{ii} = \frac{(g_{ii} - B_i W_j)}{W_i}$$

The households size elasticity of i^{th} commodity

$$e_{im} = ((\theta_i - B_i)/W_i$$

The AIDS model provides simple interpretation of the coefficients. The constant "a_i" explains the average budget share when all logarithmic prices and real expenditure coefficient "B_i" represents the change in the i^{th} expenditure with respect to any change in real income. The expenditure share "W_i" will increase with increase in total expenditure for $B_i > O$, while opposite will be true for $B_i < O$. Thus $B_i < O$ mean that the commodity is a necessity while $B_i > O$ implies that the commodity is a luxury. The price coefficient is g_{ij} implies the change in the i^{th} budget share. With respect to a percentage change in the j^{th} price with real expenditure or income held constant.

i.e., $(\partial W_i / \partial \ log\ P_j) = g_{ij}$

CHAPTER IV
DESCRIPTION OF THE STUDY AREA

A knowledge about the economic, social and physical characteristics of the study area would help the researcher to have a better understanding of the problem per se and interpretation of the results of the study. An attempt has been made to present the various characteristics of the study area including geographical features, climate and rainfall, demographic details, land use pattern, cropping pattern, irrigation details and infrastructural facilities of Nagapattinam district and Karaikal region of UT. of Pondicherry.

4.1 Nagapattinam district

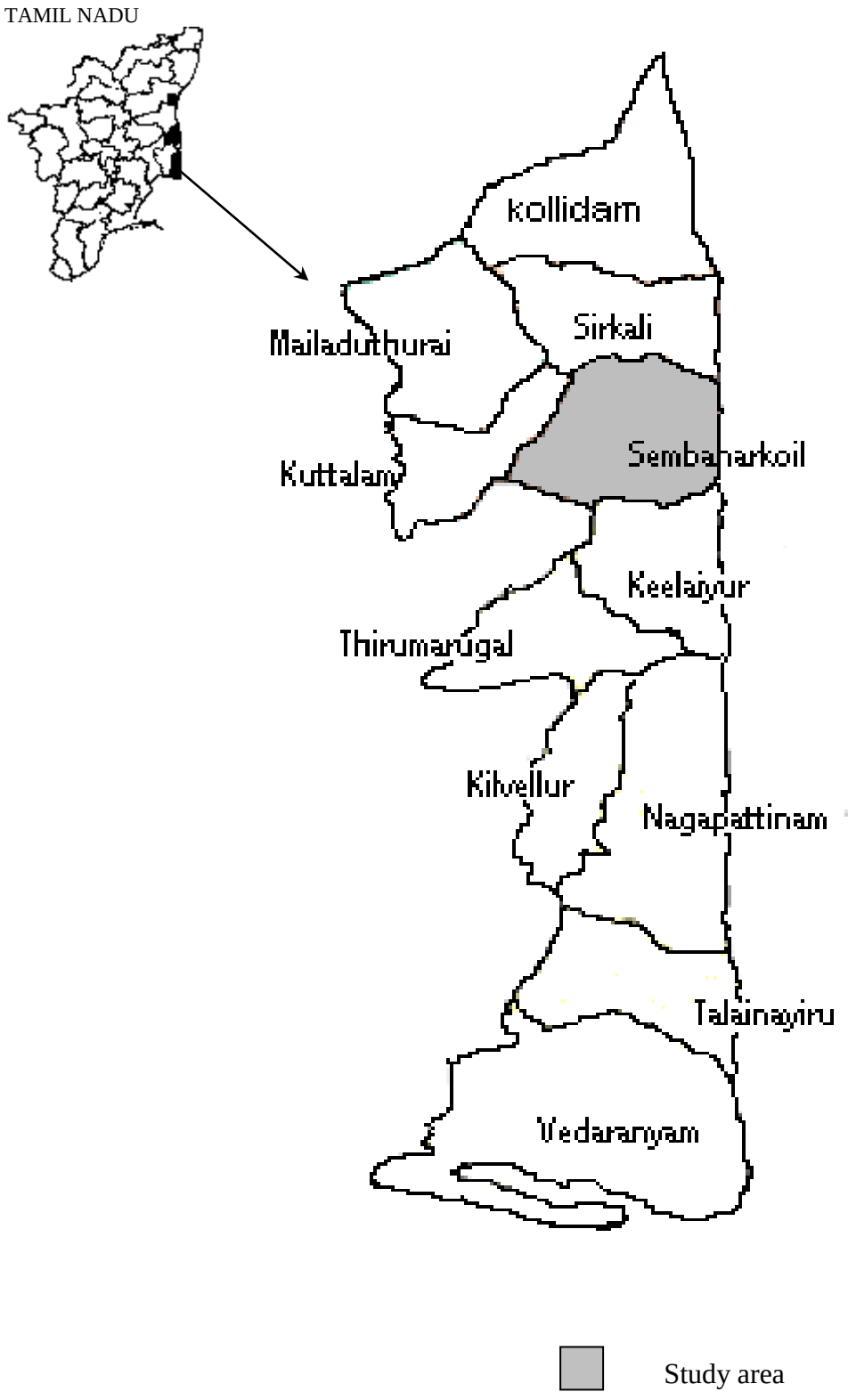
4.1.1 Geographical features

Nagapattinam district was carved out from erstwhile Thanjavur district in 1991, also called as east Thanjavur, the paddy granary of South India. It is a coastal district situated in the state of Tamil Nadu with a long coastline of 187 km. It is a peninsular deltaic district surrounded by Bay of Bengal in the east, Palk Strait in the south, Tiruvarur and Thanjavur districts in the west and the Cuddalore district in the north. It lies on the shores of the Bay of Bengal between north latitude 10^{o} 10' and 11^{o} 20' east longitude 79^{o} 15' and 79^{o} 50'. The geographical area is 2715.83 km^{2} and has a population of 14, 87,005.

The district headquarters is Nagapattinam. The district has two main revenue divisions namely Mayiladuthurai and Nagapattinam for administrative purpose. It comprises of seven taluks namely Keelavelur, Mayiladuthurai, Nagapattinam, Sirkazhi, Tharangambadi, Tirukuvalai, and Vedaranyam with 11 development blocks and 11 panchayat unions, covering 433 village panchayats (Fig 1).

Out of the 11 blocks, Sembanarkoil block was purposively chosen for the study owing to its larger area under paddy cultivation.

Fig 1. MAP SHOWING THE LOCATION OF STUDY AREA IN NAGAPATTINAM DISTRICT



Sembanarkoil block

The block is bounded by Bay of Bengal in the east, Karaikal in the south, Mayiladuthurai block in the west and Sirkazhi block in the north. Total area of the block is 165 km^2. This block occupies a major portion of Tharangambadi taluk, which includes 67 villages. Out of 67 villages of this taluk, agriculture is the main occupation of the people and paddy is the major crop cultivated. The block is located in the tail end of Cauvery delta zone and water scarcity affects the lives and living of the people who are mostly agriculturists.

4.1.2 Climate and rainfall

The climate in the district ranges from semi-arid to sub-humid. It experiences hot dry summer from March to May when temperature is fairly high going up to an average of 35^{o}c and cold weather in December and January when a minimum of 24.6^{o}c has been recorded. In general, the district has high relative humidity during October to March, when winds blow from north easterly and easterly directions. Average annual rainfall of the district is 1067 mm.

The seasonwise distribution of rainfall of the district over years is presented in Table 2. The district receives bimodal rainfall. The southwest and northeast monsoon account for 16.29 per cent and 71.17 per cent respectively of the average annual rainfall in the region. Winter rains account for 7.98 per cent while summer showers account for 4.57 per cent of the annual rainfall in the district.

In Nagapattinam district, distribution during southwest and northeast monsoons showed lesser variation among the seasons. Winter rain and summer rains exhibit high co-efficient of variation indicating the irregularity in the quantum of distribution of rainfall in this season.

4.1.3 Soil type

Sandy coastal alluvium is the predominant soil type of the district.

Table 2. Season wise distribution of rainfall in Nagapattinam district

(mm)

Year	SW monsoon (June-Sep)	NE monsoon (Oct-Dec)	Winter (Jan-Feb)	Summer (Mar -may)	Total
1993-94	160.74 (12.73)	1088.98 (86.27)	0.23 (0.02)	12.38 (0.98)	1262.33 (100.0)
1994-95	58.61 (6.67)	685.96 (78.12)	109.7 (12.49)	23.8 (2.71)	878.07 (100.0)
1995- 96	182.19 (20.33)	531.96 (59.37)	49.89 (5.57)	131.98 (14.73)	896.02 (100.0)
1996- 97	397.35 (23.45)	1227.94 (72.46)	7.18 (0.42)	62.09 (3.66)	1694.56 (100.0)
1997- 98	237.3 (12.74)	1545.95 (82.97)	52.30 (2.81)	27.64 (1.48)	1863.19 (100.0)
1998- 99	221.5 (15.65)	1057.17 (74.72)	25.63 (1.81)	110.60 (7.82)	1414.9 (100.0)
1999-00	81.88 (6.72)	943.29 (77.44)	92.1 (7.56)	100.87 (8.28)	1218.14 (100.0)
2000- 01	184.8 (13.36)	808.68 (58.44)	374.31 (27.05)	15.88 (1.15)	1383.67 (100.0)
2001- 02	241.3 (19.29)	879.43 (70.29)	6.0 (0.48)	124.5 (9.95)	1251.23 (100.0)
2002-03	114.47 (9.29)	731.69 (59.37)	341.5 (27.71)	44.8 (3.64)	1232.46 (100.0)
2003-04	294.76 (27.60)	706.91 (66.20)	5.86 (0.55)	60.28 (5.65)	1067.81 (100.0)
Average rainfall	197.71 (15.35)	928.00 (72.08)	96.79 (7.52)	64.98 (5.05)	1287.48 (100.0)
CV (%)	49.24	31.12	138.69	72.69	23.32

Figure in parentheses represent percentages to the total

Source: Office of the Joint Director of Agriculture, Nagapattinam

4.1.4 Land use pattern

A knowledge on the allocation of land among various uses would throw light on the potentials for developing farming and allied economic activities. Details on the land utilization pattern in Sembanarkoil block and Nagapattinam district is presented in Table 3.

Table 3. Land use pattern in Nagapattinam district - 2002-03

(ha)

Sl. NO	Particulars	Sembanarkoil block		Nagapattinam district	
		Area	percent to total	Area	percent to total
1.	Total Geographical area	27390	100.00	271583	100.00
2.	Area under forest	-	-	4633	1.71
3.	Barren and uncultivated land	550	2.00	33419	12.31
4.	Land put to non agricultural uses	3925	14.27	47493	17.48
5.	Cultivable waste	391	1.43	3836	1.41
6.	Permanent pastures and other grazing land	154	0.60	964	0.35
7.	Land under miscellaneous tree crops and grooves not included in the net sown area	428	1.60	10616	3.91
8.	Current fallows	2013	7.30	18122	6.67
9.	Other fallows	5916	21.60	20954	7.72
10.	Net sown area	14013	51.20	131546	48.44
11.	Area sown more than once	9507	34.7	52223	19.22
12.	Gross cropped area	23520	85.9	183769	67.7

Source: 'G' Returns register of the Assistant Director of Statistics, Nagapattinam

The geographical area of Nagapattinam district was 271583 ha. It could be discerned from the table that gross cropped area accounted for 67.7 percent of the total geographical area in the district. The net sown area occupied 48.44 per cent and land put to non-agricultural uses for 17.48 per cent. Barren and uncultivable land, total fallows and cultivable waste accounted for 12.31, 14.39 and 1.41 per cent respectively of geographical area of the district. The land under miscellaneous tree crops and forest area accounted for 3.91 and 1.71 per cent respectively of the total geographical area of the district.

The total geographical area of Sembanarkoil block was 27390 ha, which constituted about 10 per cent of the geographical area of the district. The gross cropped area of the block was 85.9 per cent of total geographical area. The net sown area of the block accounted for about 51.20 per cent of the total area of the block. Land put to non-agricultural uses accounted for about 14.27 per cent. There was no forest area in this block. The least area was under pastures accounting for 0.6 per cent and cultivable waste constituted 1.43 per cent of the total geographical area of the block. The fallow lands accounted for 28.90 per cent, which provides opportunity for utilizing these lands for cultivation.

4.1.5 Cropping pattern

A study of the crop pattern would provide an idea of the decision behaviour of the farmers on the crop-mix prevalent in the region. The distribution of area under major crops in Sembanarkoil block and Nagapattinam district is presented in Table 4.

Paddy was the dominant crop in Nagapattinam district accounting for about 75 per cent of the gross cropped area followed by pulses with 16.37 percent and sugarcane with 2.12 per cent. The oilseeds accounted for about 3.76 per cent of the gross cropped area. Area under spices and condiments, fruits and vegetable accounted for only about 0.19 and 1.52 percent respectively. The food and non-food crops occupy a share of about 95.16 per cent and 4.84 per cent respectively of gross cropped area.

Sembanarkoil block has a major area under paddy accounting for 67.01 per cent followed by pulses for 23.51 per cent of gross cropped area. The food and non-

food account for 93.96 per cent and 6.04 per cent respectively of the gross cropped area of the block.

Table 4. Area under major crops in Nagapattinam district - 2002-03

(ha)

Sl. No	Crops	Sembanarkoil block		Nagapattinam district	
		Area	percent to GCA	Area	percent to GCA
1.	Paddy	15761	67.01	137724	74.94
2.	Green gram	1767	7.51	8582	4.67
3.	Black gram	3765	16.00	21504	11.70
4.	Spices and condiments	33	0.14	366	0.19
5.	Sugar crops	328	1.39	3876	2.12
6.	Fruits and vegetables	415	1.76	2787	1.52
7.	Others	30	0.14	35	0.02
8.	Total food crops	22099	93.96	174874	95.16
9.	Cotton	533	2.27	1185	0.64
10.	Groundnut	439	1.86	2314	1.26
11.	Coconut	278	1.18	3660	1.99
12.	Gingelly	80	0.34	928	0.51
13.	Others	91	0.39	808	0.44
14.	Total non food crops	1421	6.04	8895	4.84
15.	Gross cropped area (GCA)	23520	100.0	183769	100.0

Source: 'G' Returns register of the Assistant Director of Statistics, Nagapattinam

4.1.6 Principal irrigated crops

The details of area under irrigated principal crops are presented in table 5. In Nagapattinam district, paddy was the dominant irrigated crop, and accounted for 95.12 per cent of the gross irrigated area. Next to paddy 2.11 per cent of the irrigated area was covered by sugarcane followed by cotton with 0.91 per cent. The irrigated crops under food and non-food crop category account for 98.14 per cent and 1.86 per cent respectively of the gross irrigated area of the district.

Table 5. Area under irrigated crops in Nagapattinam district - 2002-03

(ha)

Sl. No	Crop	Sembanarkoil block		Nagapattinam district	
		Area irrigated	percent to GIA	Area irrigated	percent to GIA
1.	Paddy	15161	91.44	123972	95.12
2.	Sugarcane	269	1.62	2745	2.11
3.	Fruits & vegetables	343	2.07	1185	0.91
4.	Total food crops	15773	95.13	127902	98.14
5.	Groundnut	218	1.31	744	0.57
6.	Coconut	8	0.05	136	0.11
7.	Gingelly	48	0.29	132	0.10
8.	Cotton	533	3.22	1185	0.91
9.	Tobacco	-	-	228	0.17
10.	Total non food crops	807	4.87	2425	1.86
11.	Gross irrigated area (GIA)	16580	100.00	130327	100.00

Source: 'G' Returns register of the Assistant Director of Statistics, Nagapattinam

GIA – Gross irrigated area

In Sembanarkoil block, paddy was the major irrigated crop accounting for 91.44 per cent of the gross irrigated area of the block followed by cotton with 3.22 percent, sugarcane with 1.62 per cent and 1.31 per cent of the gross irrigated area under groundnut. The irrigated area under food and non-food crop was 95.13 per cent and 4.87 per cent respectively of the gross irrigated area of the block.

4.1.7 Irrigation

The major determinant of the production performance of agriculture is availability and intensity of irrigation. Nagapattinam district is predominantly irrigated by Cauvery and Vennar river basin system and are called the old delta region. River Coleroon also acts as an irrigation source for this district. Canal irrigation water is the major source of irrigation. The water supply is dependent upon the water release of Cauvery. Besides there are small streamlets like Malligaru, Addaparu, Harichandra, Odampokkiyaru, Valapparu, Manjalaru etc., All of them depend on monsoon rains for their replenishment.

Source wise irrigation

The major sources and their relative contribution to net irrigated area are shown in tables 6 and 7.

Nagapattinam district, as a whole, has nine canals and Sembanarkoil block has one canal. The district has 14168 tube wells and Sembanarkoil block has 3084 tube wells. Canals form the principal source of irrigation accounting for 99.75 per cent of the net irrigated area indicating the predominance of canal irrigation in the district. It was also the major source in Sembanarkoil block accounting for 99.51 per cent of the net irrigated area. The irrigation intensity i.e., the proportion of gross irrigated area to the net irrigated area was 104.64 per cent in Nagapattinam district and 119.26 per cent in Sembanarkoil block.

Table 6. Sources of irrigation in Nagapattinam district - 2002-03

(numbers)

Sl. No	Particulars	Sembanarkoil block	Nagapattinam district
1.	Canals (Govt)	1	9
2.	Length of canals (km)	81	546
3.	Tube wells	3084	14168
	Govt.	7	52
	Private	3077	14,116
4.	Wells used for irrigation purpose only (Private)	-	6368
5.	Wells used for domestic purpose only	1919	31410
6.	Wells not in use	146	5439

Source: District Statistical Hand Book, Nagapattinam

Table 7. Area irrigated by different sources in Nagapattinam district - 2002-03

(ha)

Sl. No	Source	Sembanarkoil block	Nagapattinam district
1.	Govt. canals	15265 (99.51)	109833 (99.75)
2.	Tube wells	-	-
3.	Tanks	-	-
4.	Other sources	75 (0.49)	280 (0.25)
5.	Net area irrigated	15340 (100.0)	110113 (100.0)
6.	Area irrigated more than once	3624	21,209
7.	Gross area irrigated	16052	130327
8.	Irrigation intensity	104.64	119.26

Source: District Statistical Hand Book, Nagapattinam

Figure in parentheses indicate percent to net irrigated area.

4.1.8 Land holding pattern

The details on the distribution of operational land holdings of Sembanarkoil block and Nagapattinam district are furnished in the Table 8. it could be observed from the table that the holding size ranges from 0.5 to 50.0 ha. In Nagapattinam district, about 96 per cent of the small holdings were marginal and small with 74 per cent of operated area, while four per cent of large holdings cultivated a disproportionately larger area of 26 per cent indicating wide disparity in operatorship.

In Sembanarkoil block, 38.16 per cent of the operational area was cultivated by small farmers followed by marginal farmers with 33.25 per cent. About 95 percent of holdings were small and marginal farmers, which operated 71 per cent of operational area. Five per cent of large holdings has been cultivating 29 per cent of the operational area revealing inequality in land distribution in this block.

4.1.9 Demography

The demographic details of Nagapattinam district is furnished in Table 9. As per 2001 census, the total population of the district was 1,487,055 with a population density of 548 per km^2. Rural population accounted for 78 percent and urbanites for 22 per cent of the total population of the district. Literates constituted 68 percent of the total population. The working population in the district included 23.63 per cent among males and 7.74 per cent among females. Cultivators accounted for 4.65 per cent and non-workers for 6.07 per cent of the total population of the district. Nearly 21 per cent of the workers depend on agriculture.

The total population of Sembanarkoil block was 195462 of which ruralites constituted 96 per cent and urbanites for 10 per cent. The average literacy rate was 60 percent. The main workers accounted for 5.68 percent among males and 0.52 per cent among females in the total population. The cultivators and agricultural labourers constituted 5.2 per cent and 21.73 per cent of the total population respectively. Non-workers accounted for 74.66 per cent of the total population.

Table 9. Demographic details of Nagapattinam district - 2001-02

Sl. No	Particulars	Sembanarkoil block		Nagapattinam district	
		Number	Percent to total population	Number	Percent to total population
1.	Population				
	(a) Male	97158	49.70	738287	49.65
	(b) Female	98304	50.30	748768	50.35
	(c) Total	195462	100.00	1487055	100.00
2.	Rural population	175186	89.63	1157714	78.0
3.	Urban population	20276	10.37	329341	22.0
4.	Literates	3257	60.2	1010488	68
5.	Main workers				
	(a) Male	11094	5.68	351425	23.63
	(b) Female	1010	0.52	115027	7.74
6.	Rural workers	11585	5.93	373419	25.11
7.	Urban workers	521	0.27	53016	3.57
8.	Cultivators	39092	5.2	69078	4.65
9.	Agricultural labourers	42466	21.73	313174	21.06
10.	Marginal workers	43268	22.14	117875	7.93
11.	Non workers	145926	74.66	90274	6.07

Source: District Statistical Hand Book, Nagapattinam

4.1.10 Livestock details

The details of the livestock resources in Nagapattinam district are furnished in Table 10. Among the livestock population, goat population constituted 26.64 per cent followed by cattle with 25.04 percent and the buffaloes share was 6.6 percent in total livestock population. The poultry population was 535525 numbers in the district.

Table 10. Livestock population in Nagapattinam district (2001-02)

(numbers)

SL.NO	Particulars	Sembanarkoil block		Nagapattinam district	
		Nos	Percent to total	Nos	Percent to total
1.	Cattle	22491	19.22	354043	25.04
2.	Buffaloes	13944	11.92	93336	6.60
3.	Sheep	1210	1.03	12157	0.86
4.	Goat	77982	66.65	376744	26.64
5.	Others	1381	1.18	577870	40.86
6.	Total livestock	117008	100.0	1414150	100.0
7.	Total poultry	124865	100.0	535525	100.0

Source: District Statistical Hand Book, Nagapattinam

In Sembanarkoil block, the share of cattle population to the total livestock was 19.22 per cent. However, goat population was high in the block (66.65 per cent) followed by buffaloes (11.92 per cent). Thus, livestock supplements crop production in this block. The total poultry population was 124865 numbers.

4.1.11 Agricultural machinery and implements

Farm mechanization has had a credible impact on agricultural production and productivity. Details on available agricultural implements and machineries in the study area are presented in Table 11.

Table 11. Details of agricultural implements and machineries in Nagapattinam district (2001) (numbers)

Sl. No	Items	Sembanarkoil block	Nagapattinam district
1.	Ploughs		
	(a) Wooden	2285	16725
	(b) Iron	558	5271
	(c) Total	2843	21996
2.	Water pumps for irrigation purpose		
	(a) Worked by oil engine	798	6345
	(b) Worked by electric motor	2698	9740
	(c) Total	3481	16085
3.	Tractors		
	(a) Govt.	-	7
	(b) Private	297	1669
	(c) Total	297	1676
4.	Sugarcane crusher	4	-
5.	Oil ghanis	9	57

Source: District Statistical Hand Book, Nagapattinam

There were 21996 ploughs in Nagapattinam district and 2843 in Sembanarkoil block. For lifting of water, both oil engines and electric motors were used. In the district, 6345 numbers of oil engines and 9740 numbers of electric motors were available and in the block, 798 oil engines and 2698 electric motors were used. Tractors and oil ghanis were about 1676 and 57 in numbers respectively in the district and in the block, it was 297 and nine numbers respectively.

4.1.12 Infrastructural facilities

The details of transport, communication, banking and other infrastructural facilities available in the district are discussed here under.

4.1.12.1 Transport

The district has about 71kms of National Highways and 115 kms of state highways. The roads in the panchayat union and town panchayat constituted about 2298 km and 249 kms respectively, which revealed that the district has a fairly developed road network.

4.1.12.2 Communication

There were 337 post offices and 50 telephone exchanges functioning in the district to enable communication facilities.

4.1.12.3 Finance

The district has 20 bank branch offices, 122 primary cooperative banks, three primary land development banks, 14 district central cooperative banks, two urban cooperative banks, 122 primary agricultural cooperative societies and also three branches of Life Insurance Corporation.

4.1.12.4 Marketing

Two big regulated markets were in the district. Principal crops marketed were paddy, black gram and green gram. Apart from these, weekly markets were also located in a number of places in the district where mostly vegetables, fish and groceries were traded. There were 18 co-operative milk societies functioning in the district.

4.1.12.5 Medical facilities

About 17 Government hospitals, three dispensaries and 43 primary health centers were functioning with 270 doctors in the district.

4.1.12.6 Research and extension

The State Department of Agriculture has a well-coordinated organizational set up for disseminating farming technologies in Nagapattinam district.

4.2 Karaikal Region

4.2.1 Geographical features

Karaikal region is located amidst Nagapattinam district of Tamilnadu state. The mainland of the district extends between 10^{o} 49' and 11^{o} 01' north latitude and 79^{o} 43' and 79^{o} 52' east latitude. The region is bounded by the Nagapattinam and Thiruvarur districts of Tamil Nadu about 300 kilometers from south of Chennai and about 135 kilometers from Pondicherry on the east coast. The region has a geographical area of 161 km^2 with a population of 1,70,640.

The region has only one revenue division namely Karaikal for administrative purpose. It comprises of six communes viz. Karaikal, Kottucherry, Nedungadu, Thirunallar, Neravy and Thirumalairajanpattinam with one developmental block / taluk covering 37 revenue villages and 118 census villages (Fig 2).

4.2.2 Climate and Rainfall

Karaikal situated on the east coast of India in the deltaic region of the Cauvery basin experience tropical maritime type of climate. The temperature and relative humidity details are given in Table 12. December and January are the coolest months with the maximum temperature at about 28^{o}c and the minimum at about 23^{o}c. The diurnal range of temperature is generally small throughout the year, being highest (about 10^{o}c) in May and June and the least (about 5^{o}c) during November to February. The Relative humidity is quite high for most part of the year especially from June to December. The maximum humidity is recorded during North East monsoon and minimum humidity prevails during the summer months.

Fig 2. MAP SHOWING THE LOCATION OF STUDY AREA IN KARAIKAL REGION

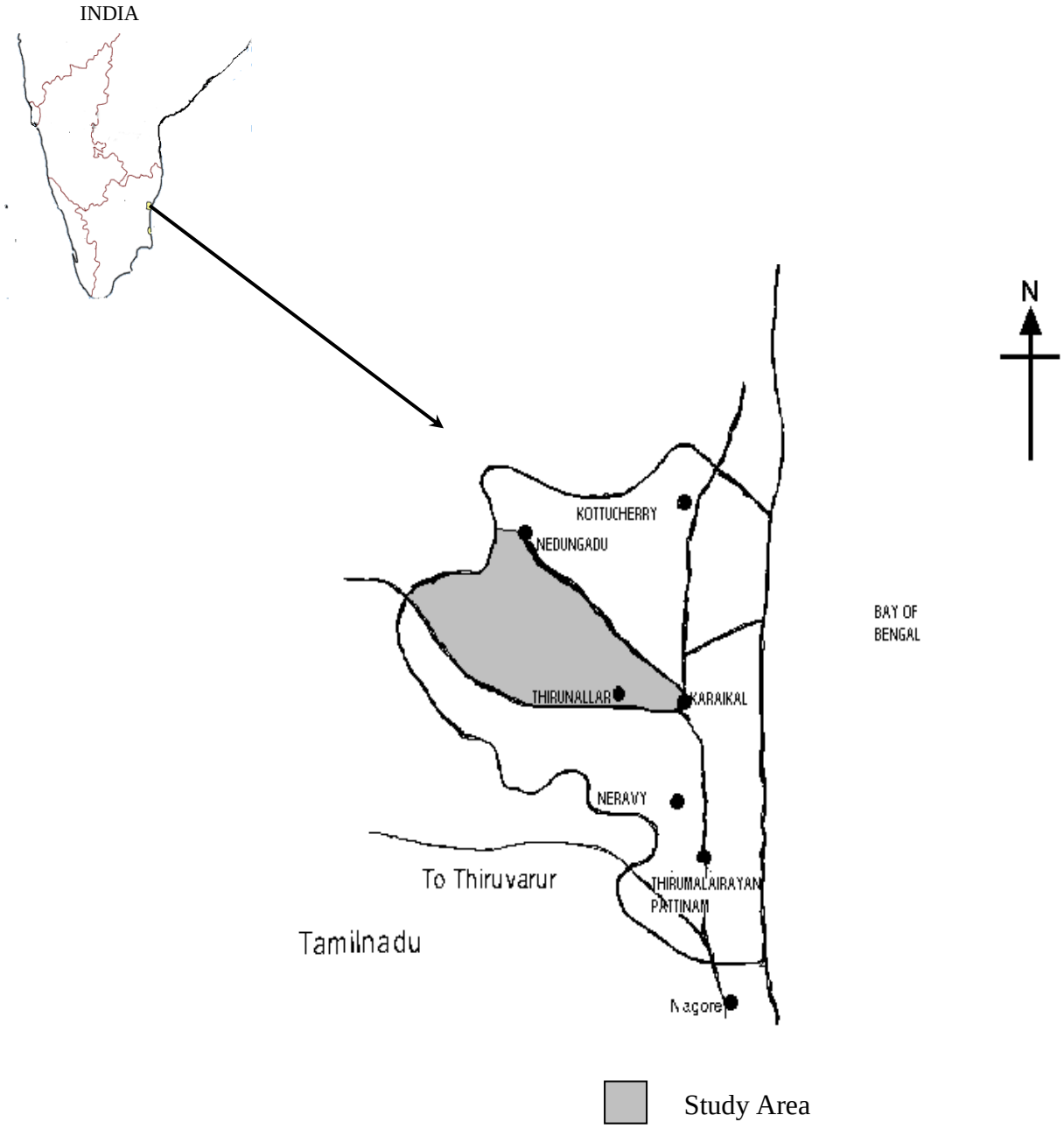


Table 12. Temperature and humidity in Karaikal region (2002-03)

Month	Temperature		Humidity (%)	
	Mean Maximum (^{o}c)	Mean Minimum (^{o}c)	8.30hrs	17.30hrs
June 2002	37.4	26.5	78	46
July	37.3	26.3	73	42
August	36.2	25.9	72	45
September	36.4	25.6	78	48
October	32.2	24.4	89	66
November	29.5	23.0	93	73
December	28.3	21.1	93	68
January	28.3	20.9	93	66
February	30.1	22.3	93	63
March	32.0	23.7	92	58
April	34.4	27.1	85	56
May 2003	37.3	28.7	79	48

Source: Season and Crop Report

The season wise distribution of rainfall of the Karaikal region over years is presented in Table 13. The district receives bimodal rainfall. The southwest and northeast monsoon account for 17.43 per cent and 64.0 per cent respectively of the average annual rainfall in the region. Winter rains account for 10.85 per cent while summer shower account for 7.72 per cent of annual rainfall in the region. Karaikal has an annual average rainfall of about 1395 mm of which 64 per cent is received during October to December. On an average, there are about 55 rainy days in a year.

In Karaikal region, distribution during southwest and northeast monsoon showed lesser variation among the seasons. Winter rains and summer rains have exhibited high co-efficient of variation indicating the irregularity in the quantum of distribution of rainfall in this season.

Table 13. Season wise distribution of rainfall in Karaikal region

(mm)

Year	SW monsoon (June – Sep)	NE monsoon (Oct – Dec)	Winter (Jan – Feb)	Summer (Mar – May)	Total
1993 – 94	302 (15.59)	1459 (75.32)	131 (6.76)	45 (2.32)	1937 (100.0)
1994 – 95	35 (2.43)	104 (76.77)	109 (7.58)	190 (13.21)	1438 (100.0)
1995 – 96	389 (27.81)	954 (68.19)	2.0 (0.14)	54 (3.86)	1399 (100.0)
1996 – 97	357 (20.79)	1267 (73.79)	39 (2.27)	54 (3.15)	1717 (100.0)
1997 – 98	250 (12.47)	1743 (86.93)	12.0 (0.60)	0.0 (0.0)	2005 (100.0)
1998 – 99	430 (26.45)	1085 (66.73)	8 (0.49)	103 (6.33)	1626 (100.0)
1999 – 00	142 (10.87)	789 (60.41)	366 (28.02)	9.0 (0.69)	1307 (100.0)
2000 – 01	252 (26.22)	613 (63.79)	1.0 (0.10)	95 (9.89)	961 (100.0)
2001 – 02	291 (17.60)	1010 (61.10)	340.0 (20.57)	12 (0.73)	1653 (100.0)
2002 - 03	223 (17.20)	739 (56.80)	316 (54.29)	22. (1.71)	1306 (100.0)
2003-04	4.25 (0.42)	62.75 (6.21)	342.25 (33.86)	601.5 (59.51)	1010.75 (100.0)
Average rainfall	252.30 (17.87)	893.25 (63.58)	151.48 (10.78)	107.80 (7.67)	1404.83 (100.0)
CV (%)	56.07	57.76	103.32	160.22	33.28

Source: Public Works Department, Karaikal.

4.2.3 Soil type

Coastal sandy soil and clay loam are the predominant soil type in the Karaikal region.

4.2.4 Topography

The region being part of the fertile Cauvery delta is completely covered by the distributaries of Cauvery and has a thick mantle of alluvium of variable thickness.

4.2.5 Land use pattern

The land use details (Table 14) revealed that the total geographical area of Karaikal region was 16199 ha accounting for 33 per cent of the total geographical area of Pondicherry state. Net sown area accounted for 49.81 per cent. Land put to non-agricultural uses, and cultivable wastelands accounted for 27.1 per cent and 13.49 per cent respectively and fallow lands for 8.4 per cent of the total geographical area of the state. The land under miscellaneous tree crops and pastures was 1.07 per cent and 0.12 per cent respectively of geographical area of the region. There was no forest and barren and uncultivable land reported in the region.

4.2.6 Cropping pattern

The distribution of area under major crops in Karaikal region is furnished in Table 15. Paddy was the dominant crop in Karaikal region occupying 83.98 per cent of the gross cropped area. Pulses were cultivated in 6.41 per cent of the gross cropped area followed by cotton with 3.71 percent. The other crops cultivated were sugarcane (0.22 per cent), oilseeds (2.9 per cent) and fruits and vegetables (0.57 per cent). The food crops accounted for 91.58 per cent and non-food crops for 8.42 per cent of the gross cropped area of the region.

Table 14. Land use pattern in Karaikal region - 2001-02

(ha)

Sl. No	Particulars	Area	Percent to total
1.	Total Geographical area	16199	100.00
2.	Forests	-	-
3.	Land put to non agricultural uses	4391	27.11
4.	Barren and uncultivable land	-	-
5.	Permanent pastures and other grazing lands	18	0.12
6.	Lands under miscellaneous tree crops not included in net area sown	173	1.07
7.	Cultivable waste	2186	13.49
8.	Other fallow land	932	5.75
9.	Current fallow land	430	2.65
10.	Net area sown	8069	49.81
11.	Area sown more than once	2163	13.40
12.	Total cropped area	10232	63.10

Source: Season and Crop Report 2001-02

Table 15. Principal crops cultivated in Karaikal region - 2001-02

(ha)

SL.NO	Crops	Area	Percent to total
1.	Paddy	8593	83.98
2.	Black gram	451	4.41
3.	Green gram	205	2.0
4.	Total food grains	9249	90.39
5.	Sugarcane	22	0.22
6.	Total fruits and vegetables	58	0.57
7.	Total condiments and spices	14	0.14
8.	Others	27	0.26
9.	Total food crops	9370	91.58
10.	Cotton	380	3.71
11.	Groundnut	50	0.49
12.	Coconut	213	2.08
13.	Sesamum	38	0.37
14.	Others	181	1.77
15.	Total non food crops	862	8.42
16.	Gross cropped area	10232	100.0

Source: Season and Crop Report 2001-02

4.2.7 Principal Irrigated crops

The details of area under irrigated crops are presented in Table 16. Paddy was the dominant irrigated crop accounted for 91.65 percent of the gross irrigated area. Next to paddy, 4.06 per cent of the irrigated area was covered by cotton followed by sugarcane with 0.23 per cent of the gross irrigated area. The total irrigated area under

food crops and non-food crops was 95.94 per cent and 4.06 per cent of the gross irrigated area of the regions respectively.

Table 16. Area under irrigated crops in Karaikal region - 2001-02

(ha)

Sl. No	Crop	Area irrigated	Percent to gross irrigated area
1.	Paddy	8593	91.65
2.	Cotton	380	4.06
3.	Sugarcane	22	0.23
4.	Total food crops	8995	95.94
5.	Total non food crops	381	4.06
6.	Gross irrigated area	9376	100.0

Source: Season and Crop Report 2001-02

4.2.8 Irrigation

Karaikal region lies in the tail end of Cauvery delta. The main source of irrigation was river water flowing through canal system. Other sources were deep bore wells and filter points. The main branches of Cauvery below Grand Anaicut are the Arasalar, Virasolanar, Vikramanar, Nattar, Vanjiar, Noolar, Nandalar etc., All of them depend on monsoon rains for their replenishment.

Source wise Irrigation

The sources and their relative contribution to net irrigated area in Karaikal region is shown in Table 17. Canals form the principal source of irrigation accounting for 99.3 per cent of the net irrigated area. The gross irrigated area was 9008 ha accounting for 88 per cent of the total cropped area. Next to canals, tube wells irrigated 0.6 per cent of the net irrigated area. The irrigation intensity was 119.44 per cent in the region.

Table 17. Source wise irrigation in Karaikal region - 2001-02

(ha)

Sl. No	Particular	Area irrigated	Percent to net irrigated area
1.	Canals	7484	99.3
2.	Tanks	-	-
3.	Tube wells	47	0.6
5.	Other sources	11	0.1
6.	Net irrigated area	7542	100.0
7.	Area irrigated more than once	1466	
8.	Gross area irrigated	9008	
9.	Percentage of gross irrigated area to total cropped area	88.04	
10.	Irrigation intensity (%)	119.44	

Source: Season and Crop Report 2001-02

4.2.9 Ground water resources

Karaikal region gets most of its water for irrigation from Cauvery and as such ground water resources in the region have not been fully developed. The water table lies at depths of 3-4 meters below ground level and during summer it declines to 6-7 meters below ground level.

4.2.10 Demography

The total population of Karaikal region was 170640, of which rural and urban people accounted for 56.40 and 43.60 per cent respectively (Table 18). The percentage of literates was 72.3 per cent and among the literates 53.8 per cent were males and the rest was females. Cultivators formed eight percent and agricultural laborers accounted for 38 per cent of the total work force.

Table 18. Demographic details of Karaikal region (2001 census)

(numbers)

Sl. No	Particulars	Number	Percent to total
1.	Population	170640	100.0
a	Male	84,365	49.48**
b	Female	86,275	50.6**
c	Rural population	96,307	56.4**
d	Urban	74,333	43.6**
2.	Literates		
a	Male	66307	53.8*
b	Female	57013	46.2*
c	Total	123320	72.3**
3	Cultivators	3678	8.09*
a	Agricultural labourers	17,286	38.0*
b	Total workers	45,453	26.7**

Source: Season and Crop Report 2001-02

*- Percentage to their respective total

** - Percentage to total population

4.2.11 Livestock and poultry

The details of livestock are given in Table 19. Cattle population constituted 45.3 per cent and goats by 44.5 per cent of total livestock. Buffaloes and sheep population accounted for 3.5 per cent and 0.92 per cent of the total livestock population respectively. The total poultry population was 36616 numbers and livestock and poultry enterprises have supplemented crop production in the region.

Table 19. Livestock and poultry population in Karaikal region (1991 census)

(numbers)

Sl. No	Particulars	Nos	Percent to total
1.	Cattle	18,180	45.3
2.	Buffaloes	1390	3.51
3.	Sheep	382	0.92
4.	Goat	17884	44.5
5.	Others	2317	5.77
5.	Total livestock	40153	100.0
6.	Fowls	36131	98.68
7.	Ducks	485	1.3
8.	Total poultry	36616	100.0

Source: Season and Crop Report 2001-02

4.2.12 Agricultural Machinery and Implements

The details of availability of agricultural machinery and implements are presented in Table 20. The total availability of ploughs was 1765 ploughs in the Karaikal region. There were 228 oil engines and 144 electric pump sets available in the region, used for lifting water. There were 99 tractors and 629 carts in the region.

4.2.13 Infrastructural and communication facilities

4.2.13.1 Transport

Karaikal region has a total road length of 165 kms. The region has a well-developed road network, which will help in the development of the region.

4.2.13.2 Communication facilities

There were 28 post offices, of which 17 offices were doing telegraphic and postal services and nine telephone exchanges were functioning in the region.

Table 20. Details of agricultural implements and machineries in Karaikal region

(numbers)

Sl. No	Items	Numbers
1.	Ploughs	1765
2.	Carts	629
3.	Tractors	99
4.	Oil engine	228
5.	Electric pump sets	144

Source: Season and Crop Report 2001-02

4.2.13.3 Finance

Banking network was very good in the region with 20 commercial bank branches, three branches of State bank of India, two state co-operative bank, one branch of land development bank and 16 cooperative credit societies to cater the credit needs of farmers.

4.2.13.4 Cooperative societies

There was only one marketing society in Karaikal region and six agricultural co-operative marketing societies, which enable farmers to sell their produce through co-operatives.

4.2.13.5 Research and extension

Department of agriculture has a well co-ordinated organizational set up for disseminating farming technologies in Karaikal region. KVK has organized various production technology schemes. The Agriculture College in the region conducts research studies on various aspects of crop and livestock production and organize training programme on crop production and management for farmers.

CHAPTER V
RESULTS AND DISCUSSION

The primary data collected from the sample farm households were analyzed using the tools of analysis specified for the study. The results obtained are discussed with respect to each of the objectives and are presented in a sequential manner in this chapter.

5.1 General characteristics of farm households

The general characteristics of farm households would give an idea about the socio-economic position of the sample farms. Household size, age, education and ownership of assets are some of the socio-personal characteristics that influence the decision-making behavior of households, which in turn will determine their adjustability and adaptability to changing agro-climatic and market conditions. A brief description of the socio-personal profile of the selected samples is discussed below.

5.1.1 Household size

The household size of the sample respondents in the study area is furnished in Table 21. It could be seen from the table that 35.6 per cent of the respondents in Nagapattinam district had a family size of less than four members. Households with members numbering from four to six, six to eight and more than eight accounted for 41.1 per cent, 16.7 per cent and 6.6 per cent respectively of the sample respondents. The average household size for the selected sample farms was five.

In Karaikal region, 50 per cent of the respondents had a family size of four to six members and about one third had a family size of less than four members. Only two sample farms had a family size with more than eight members and the average size of the household was six.

5.1.2 Age of the head of households

The age of the head of households is an important determinant of the adoption of technology. The frequency distribution of the age of the head of the households of the samples is furnished in Table 22.

Table 21. Household size of sample respondents.

Sl. No	Family size	Nagapattinam district		Karaikal region	
		Frequency (No)	Percentage to total	Frequency (No)	Percentage to total
1.	0 - 4	32	35.6	10	33.3
2.	4 - 6	37	41.1	15	50.0
3.	6 - 8	15	16.7	3	10.0
4.	>8	6	6.6	2	6.7
5.	Total	90	100.0	30	100.0
6.	Average size	5	-	6	-

Table 22 Frequency distribution of age of the heads of sample farm households

Sl. No	Age distribution (years)	Nagapattinam district		Karaikal region	
		Frequency (No)	Percentage to total	Frequency (No)	Percentage to total
1.	0 - 35	18	20.0	7	23.3
2.	36 - 45	38	42.2	7	23.3
3.	> 45	34	37.8	16	53.4
4.	Total	90	100.0	30	100.0

The table revealed that majority of the respondents were in the age group of 36 to 45 years, accounting for about 42 per cent of the samples in Nagapattinam district. This was followed by the age group of more than 45 years, which accounted for about 38 per cent of the total and about one-fifth of the respondents was below 35 years of age.

In Karaikal region, 53.4 per cent of the heads of sample households were in the age group of more than 45 years and nearly 23 per cent each were in the age group of 36 to 45 years and less than 35 years. Thus, it could be inferred that majority of the head of households, were in the age group of 36 to 45 years in Nagapattinam district and above 45 years of age in Karaikal region.

5.1.3 Educational status of the head of sample households

The information on literacy level of the head of sample farm households becomes essential because an educated farmer would normally be aware of the technical as well as institutional developments and opportunities available like credit, technology, subsidies etc. Besides, education would also enhance the farms ability to respond to avenues in non-farm activities as well. The educational status of the head of sample households is presented in Table 23.

Table 23. Educational level of the head of the sample respondents

Sl. No.	Educational status	Nagapattinam district		Karaikal region	
		Frequency (No)	Percentage to total	Frequency (No)	Percentage to total
1.	Illiterates	8	8.9	4	13.3
2.	Primary school	18	20.0	10	33.3
3.	Middle school	18	20.0	5	16.7
4.	High school	29	32.2	6	20.0
5.	Higher secondary	14	15.6	5	16.7
6	Collegiate	3	3.3	-	-
	Total	90	100.0	30	100.0

In Nagapattinam district, nearly nine per cent of the head of sample farms were illiterate. About 20 per cent each had studied upto primary and middle school level while about 32 per cent and 16 per cent were educated upto high school and higher secondary level respectively. Only three per cent of the household heads had collegiate education.

In Karaikal region, about 33 per cent of the head of sample farms had studied upto primary level followed by 16.7 per cent each upto middle school and higher secondary level while none had collegiate education. About 13 per cent of the head of households were found to be illiterate.

5.1.4 Asset position of farm households

The nature and pattern of employment is closely linked with the asset position of the farms. It reflects the financial soundness and the ability of farms to sustain

them during drought. The asset position was analyzed with respect to land, farmhouse, livestock, livestock shed, farm implements *etc.*,and the results are furnished inTable 24.

Table 24. Average asset position of the sample farms (000'Rs)

Sl. No	Particulars	Nagapattinam district	Karaikal region
1.	Land	240 (69.47)	110 (85.92)
2.	Farm house and cattle shed	91.50 (26.40)	10.67 (8.33)
3.	Livestock	8.65 (2.60)	6.37 (4.98)
4.	Farm implements	5.30 (1.53)	0.98 (0.77)
	Total	345.45 (100.0)	128.02 (100.0)

(Figures in parentheses represent percentage to column total)

An analysis of the asset position in the study region indicated that land was the major asset and accounted for 69.47 per cent and 85.92 per cent of the total asset value of sample farms in Nagapattinam district and Karaikal region respectively. The share of farmhouse and cattle shed contributed about 26.4 per cent in Nagapattinam district and 8.33 per cent in Karaikal region. Among the livestock population, milch cows occupied a significant share of total assets accounting for 2.6 per cent and 4.98 per cent in Nagapattinam district and Karaikal region respectively. The average value of total assets of selected farms in Nagapattinam district was Rs. 3,45,450 whereas it was Rs. 1,28,020 in Karaikal region. Thus, in general there existed wide variations in asset position in the two regions.

5.1.5 Land ownership and land use pattern of sample farms

Cultivators have access to land through ownership or lease. The land holding pattern of the farm households was studied as it is an important asset and a major source of living for the farms in rural areas and the results are presented in Tables 25 and 26.

Table 25. Land ownership and land use pattern of sample farms in Nagapattinam District

(ha)

Sl. No	Particulars	Wet land		Garden land	
		N	D	N	D
1.	Area owned	87.95 (75.11)	78.72 (65.82)	4.24	4.24
2.	Leased in	23.32 (19.92)	23.32 (19.50)	-	-
3.	Leased out	-	0.28 (0.24)	-	-
4.	Fallows	3.72 (3.18)	12.02 (10.05)	-	-
5.	Cultivable waste	2.10 (1.79)	5.25 (4.39)	-	-
6.	Operational area (1+2)	111.27 (95.03)	102.04 (85.32)	4.24	4.24
7.	Average size of operational holding	1.23	1.13	0.05	0.05
8.	Total area	117.09 (100.0)	119.60 (100.0)	4.24 (100.0)	4.24 (100.0)

Figures in parenthesis represent percentage to total area

D – Drought year N – Normal year

The predominance of wet and owner operated land was the characteristic feature of the sample farms in Nagapattinam district. The total land area under wetland was 119.60 ha in drought year and 117.09 ha in normal year. The share of area owned in total wetland was 65.82 per cent in drought year and 75.11 per cent in normal year while that of garden land did not show any difference in drought or normal year. The share of leased in land in total area was about 20 per cent in both drought and normal years. A decrease in the average size of wetland operational holding from 1.23 ha in normal year to 1.13 ha in drought year was observed in the sample farms. Fallows and cultivable waste have a share of 10.05 and 4.39 percent to the total area of the sample farms respectively in drought year whereas in normal year it was 3.18 and 1.79 per cent respectively.

Table 26. Land ownership and use pattern of sample farms in Karaikal region

(ha)

Sl. No	Particulars	Wet land		Garden land	
		N	D	N	D
1.	Area owned	31.20 (78.79)	30.60 (68.76)	2.60	1.00
2.	Leased in	7.40 (18.68)	6.20 (13.93)	-	-
3.	Leased out	-	1.20 (2.70)	-	-
4.	Fallows	1.00 (2.53)	3.50 (7.87)	-	-
5.	Cultivable waste	-	3.00 (6.74)	-	-
6.	Operational area (1+2)	38.60 (97.47)	36.80 (82.69)	2.60	1
7.	Average size of operational holding	1.19	1.19	0.09	0.03
8.	Total area	39.60 (100.0)	44.50 (100.0)	0.09 (100.0)	0.03 (100.0)

Figures in parenthesis represent percentage to area

D – Drought year N – Normal year

In Karaikal region, the total area under wetland of the sample farms was 44.5 ha and 39.6 ha in drought and normal year respectively. The share of operational area in total area was 82.69 per cent in drought year and 97.47 per cent in normal year. The share of wetland area owned was about 68.76 per cent in drought year and 78.79 per cent in normal year. Correspondingly, the average size of operational holding under wetland was 1.19 ha both in normal and drought year. Fallows and cultivable waste contributed a share of 7.87 and 6.74 percent in drought year and 2.53 and zero percent in normal year to the total area of the sample farms respectively. It showed that there was a positive correlation between drought on fallows and cultivable waste, which was evidently reflected by the results furnished in the table 26.

5.1.6 Irrigation

Irrigation lessens the severity of drought and hence a knowledge on area irrigated by different sources would throw light on the extent to which irrigation reduces the incidence of crop failure in the region. The details of sources of irrigation are furnished in Table 27.

Table 27. Area irrigated by different sources in sample farms (drought year)

(ha)

Sl. No	Source	Nagapattinam		Karaikal	
		Number of farms	Area irrigated	Number of farms	Area irrigated
1.	Bore well	26	38 (35.75)	14	18.30 (48.41)
2.	Canal	64	68.28 (64.25)	16	19.50 (51.59)
	Total	90	106.28 (100.0)	30	37.80 (100.0)

Figures in parentheses indicate percent of area irrigated to total irrigated area

In Nagapattinam district, area irrigated by canal formed the largest share of 64.25 per cent followed by bore wells with 35.75 per cent of the total irrigated area of the sample farms. In Karaikal region, majority of area in the sample farms was irrigated by both bore wells and canals of about 50 per cent.

5.1.7 Area under different crops in the sample farms

A Knowledge about the cropping pattern is essential to know the priority given to the various categories of food and non-food crops cultivated by the farms. The cropping pattern of sample farms in Nagapattinam district are furnished in Table 28. The year 2003-04 was a dry year with inadequate rainfall and non-release of Cauvery water. Farmers were not able to cultivate even the samba paddy due to water scarcity.

Table 28. Season wise area under different crops in sample farms of Nagapattinam district (ha)

No	Crop	Normal year				Drought year				percent change
		I	II	III	Total	I	II	III	Total	
1.	Paddy	68.68	96.17	-	164.85 (65.63)	10.56	84.20	0.80	95.56 (59.78)	-42.03
2.	Cotton	0.40	-	16.70	17.10 (6.81)	-	-	13.10	13.10 (8.21)	-23.39
3.	Black gram & Green gram	-	-	63.62	63.62 (25.33)	-	-	48.18	48.18 (30.14)	-24.36
4.	Ground nut	-	2.00	0.40	2.40 (0.96)	-	-	0.50	0.50 (0.31)	-9.16
5.	Sesame	-	-	0.80	0.80 (0.32)	-	-	0.50	0.50 (0.31)	-37.15
6.	Vegetables	-	-	-	-	-	-	2.00	2.00 (1.25)	-
7.	Sugarcane	-	2.40	-	2.40 (0.96)	-	-	-	-	-1
8.	GCA	69.08	100.57	81.52	251.17 (100.0)	10.56	84.26	65.08	159.84 (100.0)	-36.36

Figures in parentheses represent percentage to their respective total.

GCA – Gross cropped area

Paddy was the major crop of the sample farms and it covered an area of 68.68 ha in Kuruvai (I season) and 96.17 ha in samba (II season) in normal year whereas in drought year, the area under paddy in Kuruvai, Samba and III season was 10.56 ha, 84.20 ha and 0.80 ha respectively. Paddy accounted for a share of 65.63 per cent to the total gross cropped area in normal year whereas in drought year, it was 59.78 per cent. A higher percentage decline of 42.03 per cent was noticed in paddy due to drought. Cotton occupied a share of 6.81 per cent in normal year and 8.21 per cent in drought year to the total gross cropped area. The percentage decline in cotton was 23.39 per cent over the normal year. Among pulses, black gram and green gram were cultivated in rice fallows, with a share of 25.33 and 30.14 per cent in normal and drought year respectively in the selected farms, and the percentage decline

in pulses area was 24.36 percent. Regarding vegetables, no area was allocated in the sample farms for cultivation during normal year whereas it accounted for 1.25 per cent in drought year and the reason attributed by majority of the respondents was seasonality of this crop. In the event of drought, the gross cropped area declined by about 36 per cent over the normal year.

Table 29 Season wise area under different crops in sample farms of Karaikal region (ha)

Sl. No	Crops	Normal year				Drought year				percent change
		I	II	III	Total	I	II	III	Total	
1.	Paddy	35.86	38.36	-	74.22 (70.90)	27	35.96	-	62.95 (61.75)	-15.18
2.	Black gram & Green gram	-	-	21.06	21.06 (20.12)	-	-	14.0	14.00 (13.73)	-33.52
3.	Cotton	-	-	9.40	9.40 (8.98)	-	-	25.00	25.00 (24.52)	51.31
	GCA	35.86	38.36	30.46	104.68 (100.0)	27.00	35.96	39.00	101.95 (100.0)	-2.61

Figures in parentheses represent percentage to their respective total.

GCA – Gross cropped area

In Karaikal region, the major crop was paddy and in normal year, it occupied a share of 70.90 and 61.75 per cent in drought year in the sample farms (Table 29). The decline in the area of paddy was 15.18 percent over the normal year. Rice- fallow pulses accounted for 20.12 and 14.0 respectively in normal and drought year. The gross cropped area declined by 2.61 per cent in drought year when compared to normal year. Although the reduction in gross cropped area was very small; it was due to supplemental irrigation by community tube wells.

5.1.8 Cropping pattern

The cropping pattern followed by the sample farms in drought and normal years are furnished in Table 30. Majority of the respondents followed paddy – paddy – pulses rotation in normal year whereas during drought year, most of them followed paddy – pulses rotation, paddy only, paddy-cotton etc., and the land was left as fallow in the III season.

Table 30. Cropping pattern followed by the sample farms in Nagapattinam district

Sl. No.	Crop rotation	
	Normal year	Drought year
1.	Paddy – paddy – pulses	Paddy (only)
2.	Paddy – cotton	Paddy – pulses - fallow
3.	Cotton – paddy - Gingelly	Paddy – paddy - fallow
4.	Paddy – Groundnut – cotton	Paddy - chillies
5.	Paddy – paddy - cotton	Paddy - cotton
6.	Paddy – pulses	Paddy - Gingelly
7.	Paddy – cotton	Paddy - Groundnut

The crop rotation followed by the sample farms in Karaikal region (Table 31) was paddy – paddy – pulse rotation in normal year and only a paddy or paddy – pulses rotation during drought year.

Table 31. Cropping pattern followed by the sample farms in Karaikal region

Sl. No	Crop rotation	
	Normal year	Drought year
1.	Paddy – paddy – pulses	Paddy (only)
2.	Paddy – paddy - cotton	Paddy –pulse
3.	Paddy – paddy – paddy	Paddy – cotton
4.	Paddy – paddy – gingelly	-

5.2 Instability in yield

Paddy is the most important crop in the Cauvery delta zone and the production in recent years was severely affected due to water scarcity. An attempt was made to study the nature, extent and magnitude of fluctuations in the yield of paddy in all the three seasons (kuruvai, samba and thaladi) based on time-series data for the period from 1972-73 to 2001-02 in Karaikal region. Due to non availability of data for the period between 1972-73 and 1991-92, due to trifurcation of erstwhile Thanjavur district, the instability analysis has been done only for the years 1992-93 to 2002-03 in Nagapattinam district. Co-efficient of Variation (CV), Co-efficient of Variation adjusted for trend (CV_t), Probability of Crop Failure (PCF) and Crop-Loss ratio (CL) were the indicators used to study the instability in yield in the study area and the results of the instability analysis are given in Table 32.

Table 32 Indicators of yield instability in the study area

S.No	Paddy	Nagapattinam district (1992-93 to 2002-03)			Karaikal region (1972-73 to 2001-02)		
		CV_t/ CV (%)	PCF (%)	CL	CV_t/ CV (%)	PCF (%)	CL
1	I crop (Kuruvai)	25.98	0.32	28.32	22.47	0.30	23.14
2	II crop (Samba)	13.23	0.28	15.56	15.21	0.27	22.28
3	III crop (Thaladi)	30.25	0.35	35.22	29.33	0.30	20.74

For crops exhibiting a statistically significant trend, CV_t was used to net out the effect of technology on yield whereas for crops with a non-significant trend, CV was used as an indicator of instability. In Nagapattinam district, CV_t for the first, second and third season paddy crop was 25.98 per cent, 13.23 per cent and 30.25 per cent respectively. In Karaikal region, for first season paddy crop (kuruvai), CV_t was 22.47 per cent, while it was 15.21 per cent in the second season and third season crop had the highest CV_t of 29.33 per cent. In both the regions of the study area, instability indicated by CV_t was highest for the third season crop, followed by first season kuruvai, while samba had the lowest.

It is generally expected that crops occupying a larger percentage of gross cropped area will have lesser variability in yield. In Karaikal region, among the seasons, II season paddy which occupied 83.18 per cent (average for 30 years) of total area under paddy had lesser CV_t (15.21 per cent) whereas the third season paddy crop which occupied the lowest percentage area under paddy (0.38 per cent) had the highest CV_t. of 29.33 per cent and 30.25 per cent. In Nagapattinam district, the CV_t was the lowest (13.23 per cent) during II season and it was highest of 30.25 per cent during III season. Among different seasons, farms were found to allocate more area to paddy during the second season with assured irrigation.

Probability of Crop failure (PCF) given by the number of years (expressed as percentage), which yield less than 10 per cent of the trend estimate for the period, was used to identify the extent of instability in yield. In Nagapattinam district, PCF was highest (0.35 per cent) in third season paddy, followed by first season crop with 0.32 percent and was the least for second season (0.28 per cent). In Karaikal region, PCF was found to be maximum in first and third seasons (0.3 per cent) and slightly lower in second season (0.27 per cent). Between the first two seasons, kuruvai (first season) has the higher probability of crop failure than samba paddy when the irrigation was somewhat assured.

The extent of crop failure examined by the Crop - Loss (CL) ratio in both the study area indicated the magnitude of crop-loss beyond 10 per cent of the trend estimate in relation to the normal average yield for the period. In Nagapattinam district, third season paddy had the highest CL ratio of 35.22 followed by first season with the ratio of 28.32. The first season had the highest CL ratio of 23.14 in Karaikal region and other seasons had lesser ratios. The instability indices revealed that higher yield variability has been taken place in third season when compared to other seasons in both the study areas.

5.2.1 Time incidence of instability / Temporal instability

The magnitude of temporal instability was studied by examining the sequence of years with below normal (average) crop yield during the entire period. The distribution of total observations (years) with below normal yield with respect to the yield position (*i.e.* normal, above normal and below normal) in succeeding years in Nagapattinam district and Karaikal region is given in Tables 33 and 34.

Table 33. Distribution of low yield observations in relation to the yield position in succeeding years in Nagapattinam district (1992-93 to 2002-03)

S. No	Paddy / season	Year of normal / higher yields	Years of low yields in succession				
			One	Two	Three	> Four	Total
1	I crop	6 (66.67)	1 (11.11)	1 (11.11)	1 (11.11)	-	9 (100.0)
2	II crop	6 (66.67)	1 (11.11)	2 (22.22)	-	-	9 (100.0)
3.	111 crop	6 (66.67)	1 (11.11)	1 (11.11)	1 (11.11)	-	9 (100.0)

Table 34. Distribution of low yield observations in relation to the yield position in succeeding years in Karaikal region (1972-73 to 2001-02)

S. No	Paddy / season	Year of normal / higher yields	Years of low yields in succession				
			One	Two	Three	> Four	Total
1	I crop	15 (71.43)	3 (14.29)	-	1 (4.76)	2 (9.52)	21 (100)
2	II crop	17 (73.91)	3 (13.04)	2 (8.70)	-	1 (4.35)	23 (100)
3	III crop	17 (73.91)	2 (8.70)	3 (13.04)	-	1 (4.35)	23 (100)

It could be discerned from the table 33, that in Nagapattinam district, about 11 to 22 percent of total number of years with low yield was accounted for one or more of years of low yield in succession. The above findings revealed that prevalence of

low yield for one, two and three years in succession is a common occurrence in paddy crop.

In Karaikal region, one or more years with low yield in succession ranged from four to 14 per cent in paddy crop. Two and three years of low yield in succession constituted 8.7 to 13.04 per cent and 4.76 percent of the total low yield observations, respectively. Above four years of low yield in succession constituted four to nine per cent of the total low yield observations. The above findings revealed that prevalence of low yield for one, two and more than four years in succession is a common incident among the three seasons in paddy crop. It can be due to inadequate water availability.

5.2.2 Co-efficient of Variation

In order to determine the impact of water scarcity conditions on farming, an analysis of the fluctuation in crop output and area is necessary. The CVs for area, production and productivity of paddy in Nagapattinam district was worked out for the period from 1992-93 to 2002-03 (11 years) as a measure of instability and the results are furnished in Table 35.

Table 35. Co-efficient of variation for area, production and productivity of paddy crop in Nagapattinam district (1992-93 to 2002-03)

(per cent)

Paddy	Area	Production	Productivity
Crop I	26.10	30.10	32.67
Crop II	7.74	39.63	38.66
Crop III	24.40	57.58	26.55

The CV for area, production and productivity of paddy ranged from 7.74 per cent to 57.58 per cent. CV for area varied from 7.74 per cent for second crop to 26.10 per cent in the case of first crop. A lower instability was found in the case of second season when compared to the first and third season crops. In case of production, CV ranged from 30.10 per cent to 57.58 per cent and the instability was found to be the least for first season. Variation in yield ranged from 26.55 per cent in third season to 38.66 per cent in second season. When compared to production and

productivity of paddy, area exhibited the least instability in all the seasons. Among the instability in area, production and productivity of paddy, CV for production was found to be the maximum in third and second seasons while the instability in productivity was the highest for the second season crop. It could therefore be concluded from the above analysis that the instability in production in Nagapattinam district was mainly contributed by instability in productivity rather than area. The reason for highest instability in productivity was mainly due to crop loss made by natural calamities like floods and droughts.

The CV for area, production and productivity of paddy in Karaikal region was estimated for a period of 30 years from 1972-73 to 2001-02 and the results are reported in Table 36.

Table 36. Co-efficient of variation for area, production and productivity of paddy crop in Karaikal region (1972-73 to 2001-02)

(per cent)

Paddy	Area	Production	Productivity
Crop I	69.09	83.41	22.88
Crop II	11.44	16.11	15.65
Crop III	84.76	97.41	29.50

The CV for area, production and productivity of paddy varied from 11.44 per cent to 97.41 per cent. The CV for area ranged from 11.44 per cent in the second season to a maximum of 84.76 per cent in the third season and the second season paddy exhibited a lower instability in area when compared to the first and third season crops. In the case of production, the CV ranged from 16.11 per cent to 97.41 per cent and the second season paddy had lesser CV (16.11 per cent) than other two seasons. Variation in yield ranged from 15.65 per cent in second season to 29.50 per cent in third season. The instability in area, production and productivity was found to be the least in second season. In second season, variation in production was

mainly contributed by variation in yield. The instability in production of paddy was found to be the maximum in all the seasons. Area contributed more to instability in production in first and third seasons, while productivity was the major reason for instability in the second season.

5.3 Impact of rainfall on yield

To study the impact of rainfall on yield of paddy crop, season-wise detrended yield for 30 years ending 2001-02 for Karaikal region and 11 years from 1992-93 to 2002-03 for Nagapattinam district were separately regressed on rainfall (average rainfall during the months of June, July, August and September for the first season crop and September, October, November, December and January months for the second season crop) (X_1), index of seasonal deviation of rainfall from normal rainfall during the crop season (X_2), proportion of irrigated area to total area under the crop (X_3), volume of Cauvery water release (X_4), temperature (X_5) and wind speed (X_6). With the above variables included in the model, the linear estimation gave a better fit than log linear estimation and the results of the estimated linear function for Nagapattinam district and Karaikal region are presented in Tables 37 and 38 respectively.

5.3.1 Nagapattinam district

It could be discerned from the table that the variables included explained more than 35 per cent of variation in yield of paddy in first season and 71 per cent in second season. The co-efficient of multiple determination (R^2) was statistically significant in both the crop seasons implying that the explanatory variables included in the model had significant influence on crop yield. The analysis on impact of rainfall on crop yield during I season revealed that the average rainfall during the months from June to September (X_1) and the volume of water released in Cauvery river (X_4) were significantly influencing the yield of paddy positively. Every increase in release of water increased the yield i.e. one tmc release of water increased the paddy yield by 27.01kg/ha in first season. Seasonal deviation index was also significant at five per cent level.

During the second season, average rainfall during the season (X_1) and proportion of irrigated area to total cropped area (X_3) were found to be positive and

significantly influencing the yield of paddy. One percent increase in the proportion of area under irrigation to total cropped area increased the yield by 0.105 Kg/ha. Temperature and wind speed was not significant for paddy in both the seasons.

Table 37. Estimated linear regression function on impact of rainfall on crop yields in Nagapattinam district

Sl. No	Variables	I season Paddy	II season Paddy
1.	Average rainfall (x_1)	1.7309** (1.823)	19.0177** (3.1808)
2.	Seasonal derivation index (x_2)	81.0575** (1.899)	86.9803 (1.4544)
3.	Proportion of irrigated area to total cropped area (x_3)	1.5718 (0.249)	0.1051* (2.544)
4.	Volume of water released in cauvery (x_4)	27.0122** (1.912)	0.0008 (1.524)
5.	Temperature (x_5)	37.7854 (0.839)	65.5389 (-1.50)
6.	Wind speed (x_6)	12.31118 (0.776)	37.7854 (0.839)
7.	Constant/intercept (x_0)	4886.729* (2.310)	5126.715 (3.9014)
8.	R^2	0.35*	0.71*
9.	F	3.82	5.83
10.	n	11	11

't' values are given in parentheses
* Significant at 5 per cent level
** Significant at 1 per cent level
n = number of observations

5.3.2 Karaikal region

From Table 38, it could be seen that rainfall had significant influence on yield of paddy crop in both the seasons. R^2 ranged from 0.34 to 0.40 and was statistically significant in both the seasons. In the analysis for season I, the coefficient for average rainfall during the seasons (X_1) was found to be positive and statistically significant at

five percent level. This implies that for every one mm increase in rainfall, the yield increases by 1.09 Kg/ha.

In season II, the coefficient for average rainfall during the seasons (X_1) and proportion of irrigated area to the total area under the crop (X_3) were positive and significant at five per cent level. The results indicated that rainfall in first season crop and rainfall, irrigated area in the second season crop were the major factors influencing variation of crop yield in Karaikal region.

Table 38. Estimated linear regression function on impact of rainfall on crop yields in Karaikal region

Sl. No	Variables	I season Paddy	II season Paddy
1.	Average rainfall RF(x_1)	1.095* (2.73)	1.6509* (2.064)
2.	Seasonal derivation index (x_2)	45.028 (0.1560)	-56.9863 (-1.4854)
3.	Proportion of irrigated area to total cropped area (x_3)	0.0695 (0.828)	0.1023* (2.2239)
4.	Volume of water released in cauvery (x_4)	-3.094 (-0.504)	5.582 (0.070)
5.	Temperature (x_5)	-44.2569 (-0.776)	-34.2534 (-0.648)
6.	Wind speed (x_6)	26.3537 (1.203)	10.9411 (0.724)
7.	Constant/intercept (x_0)	2177.85 (7.052)	3413.506 (7.096)
8.	R^2	0.34*	0.40*
9.	F	3.23	3.51
10.	n	30	30

't' values are given in parentheses
* Significant at 5 per cent level ** Significant at 1 per cent level
n= number of observations

5.4 Cost of cultivation of paddy in the study area

5.4.1 Nagapattinam district

The cost of cultivation of paddy in Nagapattinam district was estimated separately for drought year and normal year.

Fixed cost:

The cost of cultivation of paddy for the sample farms in Nagapattinam district was estimated for drought year and normal year and the results are furnished in Tables 39, 40 and 41. The cost of cultivation was worked out for samba season, because only a few farms were cultivating other season paddy due to water scarcity condition. The total fixed cost incurred during normal year and drought year was Rs.5476.36 and Rs. 4559.64 per ha respectively. Rent for land constituted a major share in fixed cost accounting for about 47.70 per cent in normal year and 38.72 per cent in drought year followed by interest on fixed capital with 24.77 per cent and 29.74 per cent in normal and drought year respectively. While depreciation and land revenue constituted 20.68 and 6.85 per cent respectively in the normal year, it accounted for 24.84 and 6.70 per cent respectively in drought year.

Table 39. Average cost of cultivation of paddy in Sample farms in Nagapattinam district – Fixed cost. (Rs/ha)

Sl. No	Particulars	Normal year	Drought year
1.	Rent	2612.00 (47.70)	1765.28 (38.72)
2.	Land revenue	375.28 (6.85)	305.28 (6.70)
3.	Depreciation	1132.76 (20.68)	1132.76 (24.84)
4.	Interest on working capital	1356.32 (24.77)	1356.32 (29.74)
	Total	5476.36 (100.0)	4559.64 (100.0)

Figure in parentheses represent percentage to the total fixed cost

Variable cost

The total variable cost of cultivation per ha for the sample farms worked out to Rs. 12079.45 for normal year and Rs. 8614 for drought year. In the case of nursery, seeds and sowing and manures and fertilizers accounted for the major share. In the main field, manures and fertilizers accounted for 19.51 per cent in normal year and 19.14 per cent in drought year. The operation that accounted for second major share

was transplanting which was about one-tenth of the total variable cost. The cost incurred during normal year for transplanting and weeding was 10.34 and 7.90 per cent respectively whereas for drought year, it was 9.12 and 8.17 per cent respectively. Interest on working capital contributed 5.66 per cent of total variable cost in both the years. Even though a substantial decline in share of various operations in total cost was not found, the absolute cost of almost all the operations declined significantly in drought year reducing the cost of cultivation by 28.69 per cent when compared to normal year.

Table 40. Average cost of cultivation of paddy in sample farms in Nagapattinam district – Variable cost (Rs/ha)

Sl. No.	Particulars	Normal year	Drought year
	Nursery:		
1.	Preparatory cultivation	247.84 (2.05)	175.26 (2.03)
2.	Seeds and sowing	542.30 (4.48)	422.32 (4.90)
3.	Manures and fertilizers	480.28 (3.97)	326.00 (3.78)
4.	Plant protection	32.30 (0.26)	14.05 (0.16)
5.	Irrigation	60.75 (0.50)	60.75 (0.72)
	Main field:		
6.	Preparatory cultivation	782.35 (6.47)	722.46 (8.39)
7.	Manures and fertilizers	2357.26 (19.51)	1648.67 (19.14)
8.	Pulling out of seedlings	1020.00 (8.44)	653.65 (7.59)
9.	Transplanting	1250.00 (10.34)	786.00 (9.12)
10.	After cultivation (weeding)	955.36 (7.90)	704.00 (8.17)
11.	Irrigation	690.25 (5.75)	700.38 (8.13)
12.	Plant Protection	826.35 (6.84)	485.56 (5.64)
12.	Harvesting and thrashing	2150.67 (17.82)	1427.52 (16.57)
13.	**Total**	11395.71 (94.33)	8126.62 (94.34)

14.	Interest on working capital	683.74 (5.66)	487.59 (5.66)
15.	**Total variable cost**	12079.45 (100.00)	8614.21 (100.00)

Figure in parentheses represent percentage to the total variable cost

Cost and returns for paddy crop

The results (Table 41) indicated that the total cost of production of paddy crop was Rs. 17555.81 per ha and Rs. 13173.85 per ha respectively for normal year and drought year. The share of variable and fixed cost to the total cost of production was about 68.81 and 31.19 per cent for normal year while it was 65.39 per cent and 34.61 per cent in drought year. The gross income, gross margin and net income obtained during normal year were Rs. 23850, 11771 and Rs.6294 respectively while the respective figures for drought year was Rs. 16000, 7386, 2826 respectively. The analysis of cost and returns reflected the changes in cost components in crop cultivation during drought year. The variable and fixed costs were declined by 28.69 and

16.74 per cent when compared to the normal year. The total cost of cultivation has been reduced by 24.96 per cent during drought year. The crop yield was come down by 28.89 per cent and it ultimately reduced the net return by 55.09 per cent from the normal year.

Table 41. Average cost and returns of cultivation of paddy in sample farms in Nagapattinam districts (Rs/ha)

Sl. No	Particulars	Normal	Drought	Percent decline
1.	Variable cost	12079.45 (68.81)	8614.21 (65.39)	28.69
2.	Fixed cost	5476.36 (31.19)	4559.64 (34.61)	16.74
3.	Total cost	17555.81 (100.00)	13173.85 (100.00)	24.96
4.	Yield (kg/ha)	4500.00	3200.00	28.89
5.	Gross income	23850.00	16000.00	32.91
6.	Gross margin (5-1)	11770.55	7385.79	37.25
7.	Net income (5-3)	6294.19	2826.18	55.09

5.4.2 Karaikal region

The cost of cultivation of paddy in Karaikal region was estimated separately for drought year and normal year and the results are furnished in Tables 42, 43 and 44.

Fixed cost

It could be seen from the Table 42 that the Total fixed cost incurred during normal and drought years for Karaikal region was Rs.5087.92 and Rs.4693.33 per ha respectively. Rent for land constituted a major share in fixed cost accounting for about 39.02 per cent in normal year and 34.53 per cent in drought year. The second major component in fixed cost was interest on fixed capital accounting for 31.09 per cent and 33.71 per cent of total fixed cost in normal and drought year respectively. While land revenue and depreciation constituted 5.60 and 24.29 per cent respectively in the normal year and it was 5.44 and 26.32 per cent respectively in drought year.

Table 42. Average cost of cultivation of paddy for sample farms in Karaikal region – Fixed cost (Rs/ha)

Sl. No	Particulars	Normal year	Drought year
1.	Rent for leased in land	1985.28 (39.02)	1620.37 (34.53)
2.	Land revenue	285.37 (5.60)	255.37 (5.44)
3.	Depreciation	1235.27 (24.29)	1235.27 (26.32)
4.	Interest on working capital	1582.00 (31.09)	1582.32 (33.71)
5.	Total	5087.92 (100.0)	4693.33 (100.0)

Figures in parentheses represent percentage to total fixed cost

Variable cost

The total variable cost of production per ha was worked out to be Rs 12432.59 in normal year and Rs 10620.18 in drought year. In the case of nursery, seeds and sowing, manures and fertilizers and plant protection accounted for about 3.88, 3.62,

0.33 per cent respectively in normal year and 3.76, 3.55, 0.17 per cent respectively in drought year. But the cost on irrigation was higher in drought year (0.96 per cent) when compared to the normal year (0.56 per cent).

In the cost of cultivation, about two-fifth of the cost was spent on manures and fertilizers and harvesting. Preparatory cultivation accounted about 7.04 per cent in normal year and 7.06 per cent in drought year. The share of manures and fertilizers in total variable cost slightly declined in drought year (18.69 per cent) when compared to the normal year (20.41 per cent). Irrigation cost was higher in drought year when compared to the normal year and it increased by 66.66 per cent from normal year. The share of plant protection chemicals declined from 6.86 to 5.61 percent. The cost incurred during normal year for harvesting was 19.97 per cent of the total variable cost whereas it was 18.12 per cent in drought year. Interest on working capital accounted 5.66 per cent in both the normal and drought years.

Table 43. Average cost of cultivation of paddy in sample farms in Karaikal region – Variable cost

(Rs/ ha)

Sl. No.	Particulars	Normal year	Drought year
	Nursery:		
1.	Preparatory cultivation	298.37 (2.39)	195.23 (1.83)
2.	Seeds and sowing	482.29 (3.88)	399.35 (3.76)
3.	Manures and fertilizers	450.37 (3.62)	377.28 (3.55)
4.	Plant protection	41.23 (0.33)	18.25 (0.17)
5.	Irrigation	70.00 (0.56)	102.68 (0.96)
	Main field:		
6.	Preparatory cultivation	875.23 (7.04)	793.28 (7.06)
7.	Manures and fertilizers	2537.18 (20.41)	1985.63 (18.69)
8.	Pulling out of seedlings	965.27 (7.76)	725.38 (6.8)
9.	Transplanting	1127.32 (9.07)	985.67 (9.2)

10.	After cultivation (weeding)	826.35 (6.65)	714.39 (6.15)
11.	Irrigation	720.35 (5.79)	1200.32 (12.44)
12.	Plant Protection	852.53 (6.86)	596.35 (5.61)
12.	Harvesting and thrashing	2482.37 (19.97)	1925.23 (18.12)
13.	**Total**	11728.86 (94.34)	10019.04 (94.33)
14.	Interest on working capital	703.73 (5.66)	601.14 (5.66)
15.	**Total variable cost**	12432.59 (100.00)	10620.18 (100.00)

Figure in parentheses represent percentage to total variable cost

Cost and returns:

The results (Table 44) indicated that the total cost of cultivation per hectare of paddy was Rs.17520 and Rs. 15313 for normal year and drought year respectively. The share of variable and fixed cost to the total cost of production was about 70.96 per cent and 29.04 per cent in normal year and 69.35 per cent and 30.65 per cent in drought year. The gross income, gross margin and net income obtained during normal year were Rs 23100, 10748 and 5660 respectively while the corresponding figures for drought year were Rs. 16520, 5965 and 1242 respectively. The comparison of cost and returns between normal and drought year revealed that the total cost of cultivation has been reduced by 12.60 per cent, whereas the variable cost and fixed cost were reduced by 14.58 and 7.76 per cent respectively. The reduction in yield was profound by 33.33 per cent, which ultimately cutdown the net income by 78.05 per cent. This showed the severe impact of drought in Karaikal region.

Table 44. Cost and returns of cultivation of paddy in the sample farms in Karaikal region. (Rs / ha)

Sl. No	Particulars	Normal	Drought	Percent decline
1.	Variable cost	12432.59 (70.96)	10620.18 (69.35)	14.58
2.	Fixed cost	5088.24 (29.04)	4693.33 (30.65)	7.76
3.	Total cost	17520.83 (100.0)	15313.51 (100.0)	12.60
4.	Yield (kg/ha)	4200	2800	33.33

5.	Gross income	23100	16520	28.49
6.	Gross margin (5-1)	10747.94	5965.38	44.49
7.	Net income (5-3)	5659.7	1242.05	78.05

5.5 Pattern of employment

The employment pattern of the household will determine its level of income, which in turn determines the expenditure on food and non-food items. The average number of days (mandays) employed per month by the sample respondents furnished in Table 45, gives a comprehensive view of the days of employment during lean and peak seasons in the study area. On an average, for the sample respondents as a whole in Nagapattinam district, the number of days employed per month was 15.99 mandays in drought season and 22.44 mandays in normal year, whereas in Karaikal region, the average number of days employed was 18.93 and 23.59 mandays in drought and normal year respectively. In case of Nagapattinam district, in drought year the number of days of employment was found to be 18.74 and 13.23 mandays in peak and lean months respectively and it was 24.32 and 20.56 mandays in normal year. There existed considerable difference in the number of days of employment in peak and lean season in both drought and normal years. The number of days of employment for sample farms in Karaikal region was 20.63 mandays and 17.22 mandays in peak and lean months respectively in drought year and 25.89 mandays and 21.28 mandays in normal year. These results indicated that employment opportunities were reduced by 28.74 per cent in Nagapattinam district and by 19.75 per cent in Karaikal region during drought year when compared to the normal year.

Table 45. Average number of days employed per month by the sample households (mandays)

Sl. No	Particulars	Nagapattinam			Karaikal		
		N	D	percent change	N	D	percent change
1	Peak season	24.32	18.74	-22.94	25.89	20.63	-20.32
2	Lean season	20.56	13.23	-35.65	21.28	17.22	-19.08

3	Average	22.44	15.99	-28.74	23.59	18.93	-19.75

The availability of more employment opportunities ultimately leads to improvement in the standard of living. So the employment pattern of the sample households in farm as well as non-farm activities was studied and the details are furnished in Table 46. In Nagapattinam district, the average number of days employed per annum was 264.83 mandays in drought year and 298.78 mandays in normal year. The reduction in total employment per annum was 11.36 per cent due to drought.The on-farm employment constituted a major share in total employment followed by off-farm and non-farm employment in that order. The farms in Nagapattinam had 100.72 mandays of on-farm employment in drought year and 162.53 mandays in normal year. The on-farm employment was declined by 38.02 per cent during drought when compared to normal period. In drought year, the off-farm and non-farm activities contributed 91.68 and 72.43 mandays respectively while in normal year, 87.61 and 48.64 mandays respectively. The off-farm and non-farm employment had been increased by 4.65 per cent and 48.91 per cent respectively during the drought period.

Table 46. Details of employment pattern of the sample farms in selected districts

(mandays / year)

Sl. No	Particulars	Nagapattinam			Karaikal		
		N	D	percent change	N	D	Percent change
1	On-farm	162.53	100.72	-38.02	154.18	98.35	-36.21
2	Off-farm	87.61	91.68	4.65	82.57	81.58	-1.19
3	Non-farm	48.64	72.43	48.91	52.36	87.82	67.72
4	Total	298.78	264.83	-11.36	289.11	267.75	-7.39

In Karaikal region, the average number of mandays of employment per annum was 267.75 mandays in drought and 289.11 in normal year. The reduction in employment generation was 7.39 per cent due to drought. The impact of the drought

has been pronounced severely in on-farm employment generation. The reduction in on-farm employment was 36.21 per cent when compared to the normal year. The reduction in on-farm employment had been compensated by the generation of employment in non-farm activities. The employment generation was very high to the tune of 67.72 per cent in non-farm activities. The creation of employment by off-farm activities reduced by a meager one per cent only.

The findings of the study indicated that employment opportunities in on-farm activities were reduced in drought year when compared to the normal year. Due to water scarcity condition in the study area, farms shifted from on-farm activities to non-farm and off-farm activities. So a reduction in on-farm employment and an increase in off-farm and non-farm employment were observed during drought year.

5.6 Pattern of income generation

The access of household to food is mainly determined by the income (farm and non-farm), which is considered as one of the important indicators of food security. The details of the total income realized per annum through on-farm, off-farm and non-farm activities by the different categories of sample respondents in the study area are furnished in Table 47. The average income received by the sample households in Nagapattinam district was Rs.48263 per year in drought year and Rs.70,535 in normal year. Due to drought, the average income of the sample households reduced by 31.58 per cent. The share of income from on-farm activities was 22.76 per cent and 64.35 per cent in drought and normal year respectively. The off-farm activities contributed 27.66 per cent of total income in drought year whereas it declined to 20.76 per cent in normal year. An increase in the share of contribution of non-farm activities towards total income from 14.89 per cent in normal year to 49.58 per cent in drought year was found. The non-farm income contributed much in income basket of sample farms. It increased by 127.80 per cent during drought year when compared to the normal year

In Karaikal region, the share of income from on-farm activities was 23.10 per cent and 63.84 per cent in drought and normal year respectively. The off-farm activities contributed 28.48 per cent of total income in drought year whereas it declined to 20.76 per cent in normal year. There was an increase in share of

contribution of non-farm activities towards total income from 15.40 per cent in normal year to 48.42 per cent in drought year. The percentage change in the off-farm income was declined by 4.97 per cent between normal and drought year. The non-farm employment had been raised by 117.73 per cent due to drought. The reduction in total income generation was 30.73 per cent because of drought. The shift in employment from on-farm to off-farm and non-farm activities during drought year was the reason for the reduction in the share of income from on-farm activities and increase in share to off-farm and non-farm activities.

Table 47. Pattern of income realization through different activities in the study area (Rs/Year)

Sl.No	Particulars	Nagapattinam			Karaikal		
		N	D	percent change	N	D	percent change
1	On-farm	45387.98 (64.35)	10982.37 (22.76)	-75.80	49159.00 (63.84)	12325.34 (23.10)	-74.93
2	Off-farm	14646.40 (20.76)	13352.00 (27.66)	-8.84	15987.32 (20.76)	15193.30 (28.48)	-4.97
3	Non-farm	10500.37 (14.89)	23928.27 (49.58)	127.88	11862.32 (15.40)	25828.32 (48.42)	117.73
4	Total	70534.75 (100.0)	48262.64 (100.0)	-31.58	77008.69 (100.0)	53346.96 (100.0)	-30.73

Figures in the parentheses represent percentage to respective total.

5.7 Consumption pattern in sample households

The consumption expenditure on food as well as non-food items is a direct function of income and varies among different categories of households. The details of the average monthly expenditure on individual food items of the selected sample farms in Nagapattinam district and Karaikal region are furnished in Tables 48 and 49. For Nagapattinam district (Table 48), the average monthly consumption expenditure on food items for selected small farms was Rs 1465.48 for normal year and Rs 1147.62 for drought year, whereas in large farms it was Rs 1924.1 and Rs 1654.41 for

normal and drought year respectively. The decline in consumption expenditure on food items in the drought year (as compared to the normal year) was 21.69 per cent in small farms and 14.02 in large farms.

In both the categories, the magnitude of decline in consumption expenditure varied significantly among the different items of consumption. The extent of decline in various food items ranged between 10.22 per cent in the case of rice and 58.08 per cent for milk in small farms and in large farms it varied from 4.72 per cent for pulses to 30.38 per cent for fruits in Nagapattinam district. The decline in the consumption of rice in the drought year was less when compared to all other food items and also an increase in consumption expenditure by 19.87 per cent during drought year was found only in the case of other cereals (coarse cereals and millets) in small farms. The substitution of rice by other cereals has been taken place in large farms also, by increase in consumption expenditure by 5.68 per cent in this item. This clearly indicated that even in large farms, they substitute rice with less preferred low value cereals like ragi, cumbu, etc.

In Karaikal region (Table 49), the average monthly consumption expenditure on food items for all the selected small farms was Rs 1462.97 for normal year and Rs 1132.18 for drought year, whereas in large farms it was Rs 1779.28 and Rs 1579.50 for normal and drought year respectively. The decline in consumption expenditure in the drought year (as compared to the normal year) was 22.61 per cent in small farms and 11.23 in large farms. The extent of decline of various food items varied in Karaikal region from 8.76 per cent in the case of rice to 55.18 per cent for milk in small farms and in large farms it declined from 3.04 per cent for rice to 20.69 per cent for oils in Karaikal region. The decline in the consumption of rice in the drought year was less when compared to all other food items for the selected small and large farms

The details of the average monthly consumption expenditure on non-food items for selected respondents in Nagapattinam district was furnished in Table 50. In small farms, the average non-food expenditure per farm was Rs 836.19 for the normal year and Rs.651.83 for drought year whereas for large farms it was estimated to be Rs. 1078.71 and 913.99 for normal and drought year respectively. The consumption expenditure on non-food items for drought year (as compared to normal year)

declined by 22.05 percent in small farms and 15.27 per cent in large farms. In Nagapattinam district, the expenditure on clothing and shelter declined by 36.55 per cent and 8.98 per cent in small farms whereas in large farms, the decline was 9.99 and 21.10 per cent respectively. The extent of decline of various non–food items varied from 6.24 for other items to 36.55 for clothing in small farms and in case of large farms it varied from 5.72 for education to 26.05 for transport.

The details of the average monthly consumption expenditure on non-food items for selected respondents in Karaikal region was furnished in Table 51. In small farms, the average non-food expenditure per household was Rs 893.85 for the normal year and Rs.709.14 for drought year whereas for large farms it was estimated as Rs. 1057.04 and 946.26 for normal and drought year respectively. The consumption expenditure for drought year (as compared to normal year) had declined by 20.66 percent in small farms and 10.48 per cent in large farms. In Karaikal region, the expenditure on clothing and shelter declined by 32.80 per cent and 15.05 per cent in small farms whereas in large farms the decline for same items was 4.68 and 7.09 per cent respectively. The extent of decline for various non–food items varied from 2.36 for education to 32.80 for clothing in small farms and in case of large farms it varied from 4.68 for clothing to 21.29 for fuel.

The total consumption expenditure of food and non-food items in the sample farms is furnished in the Table 52. In Nagapattinam district, percentage decline in consumption expenditure of food and non-food items accounted for 21.69 per cent and 22.05 per cent in drought year when compared to the normal year in small farms, whereas in large farms it accounted for 14.02 per cent and 14.22 per cent. In Karaikal region, percentage decline in monthly consumption expenditure of food and non-food items accounted of about 22.61 per cent and 20.69 per cent in drought year when compared to the normal year in small farms, whereas in large farms it accounted for 11.23 per cent and 8.60 per cent. The total consumption expenditure declined by 21.84 per cent in small farms and 14.47 in large farms over the normal year in Nagapattinam district whereas in Karaikal region, it was declined by 21.87 per cent and 10.95 in small and large farms respectively.

Table 52. Average monthly consumption expenditure of food and non-food items in the study area

Sl. No.	Items	Nagapattinam district		Karaikal region	
		Per cent change		Per cent change	
		Small farms	Large farms	Small farms	Large farms
1.	Food	-21.69	-14.02	-22.61	-11.23
2.	Non-food	-22.05	-14.22	-20.69	-8.60
3.	Total	-21.84	-14.47	-21.87	-10.95

5.8 Crop diversification

Agricultural diversification has emerged as an important alternative to attain the objectives of output growth, employment generation and sustainability in the use of natural resources. Crop diversification has been estimated using various measures to capture distribution and diversity of crops. In the present study, Herfindahl index was used to estimate the crop diversification using secondary data for drought and normal years in the study area and the results are furnished in Table 53.

Table 53. Crop diversification index for the sample farms

Study area	Normal year	Drought year
Nagapattinam	0.451	0.533
Karaikal	0.411	0.709

It could be observed from the table that the index of crop diversification for Nagapattinam district was 0.53 in drought year and 0.45 in normal year. This implied that there was less crop diversification in drought year when compared to the normal year. In Karaikal region, the crop diversification index was 0.7 and 0.4 in drought and normal year respectively. The diversification index is bounded by zero for total diversification and one for total specialization. Contrary to the phenomenon here, the results indicated that farms were not adopting any crop diversification in the drought year when compared to the normal year.

5.9 Farm diversification

Diversification is the integral part of the process of structural transformation. Farm diversification may be adopted as a strategy for profit maximization and stabilization of farm income through reaping the gains of complementary and supplementary relationship. The major strategy adopted by farm households to sustain household income is to diversify income sources to all the sub sectors like crop, livestock, other non-crop enterprises *etc.,* the share of different sub sectors in total income from all sources was found out based on primary data collected for normal and drought years and the Herfindahl index was estimated. The index is bounded by zero (total diversification) and one (total specialization).

The sub sector wise composition of income generated from all the sources during drought and normal year was calculated and the estimates of diversification analysis are presented in Table 54. The sample farms were classified into different groups based on the index of diversification. In Nagapattinam district, a high level of farm diversification (Index value between 0.3 and 0.5) was found in the case of 54.10 per cent and 55.17 per cent of small and large farms respectively in drought year while it was 17.46 and 29.63 percent during normal year. In the case of small farms, a moderate diversification of 0.5 to 0.7 was found in the case of 13.11 and 28.57 per cent respectively in drought and normal year whereas for large farms, it was 17.24 and 18.52 per cent respectively. In the case of 32.79 and 27.59 percent of small and large farms, a low level of farm diversification (0.7 to 1.0) was found in drought year whereas in normal year the diversification was low in these farms by 53.97 and 51.85 per cent of small and large farms respectively. This implied that small farms diversify their income to different sub sectors when compared to the large farms in drought season. In normal year, most of the small and large farms followed moderate diversification or complete farm specialization. The results of the study indicated increased diversification of small farms than large farms to different sub sectors in order to sustain household income in drought year.

Table 54 Farm diversification among sample households in Nagapattinam District

Sl. No	Diversification index	Normal year		Drought year	
		Small farmer	Large farmer	Small farmer	Large farmer
1.	0.3–0.5	11 (17.46)	8 (29.63)	33 (54.10)	16 (55.17)
2.	0.5–0.7	18 (28.57)	5 (18.52)	8 (13.11)	5 (17.24)
3.	0.7–1.0	34 (53.97)	14 (51.85)	20 (32.79)	8 (27.59)
4.	Total	63 (100.0)	27 (100.0)	61 (100.0)	29 (100.0)

Figures in the parentheses represent percentage to respective total.

In Karaikal region (Table 55), a high level of farm diversification (Index value between 0.3 and 0.5) was found in the case of 52.63 per cent and 54.55 per cent of small and large farms respectively in drought year and 20 percent each during normal year. In the case of small farms, a moderate diversification of 0.5 to 0.7 was found in the case of 26.32 and 25.0 per cent respectively in drought and normal year whereas for large farms, it was 18.18 and 20.0 per cent respectively. In the case of 21.05 and 27.27 percent of small and large farms, a low level of farm diversification (0.7 to 1.0) was found in drought year whereas in normal year, the diversification was low in these farms for 55 and 60 per cent of small and large farms respectively. This implies that small farms diversify their income to different sub sectors. Therefore, there is a good scope to increase the income through farm diversification.

Table 55. Farm diversification among sample households in Karaikal region

Sl. No	Diversification index	Normal year		Drought year	
		Small farmer	Large farmer	Small farmer	Large farmer
1.	0.3–0.5	4 (20.0)	2 (20.0)	10 (52.63)	6 (54.55)
2.	0.5–0.7	5 (25.0)	2 (20.0)	5 (26.32)	2 (18.18)
3.	0.7–1.0	11 (55.0)	6 (60.0)	4 (21.05)	3 (27.27)
4.	Total	20 (100.0)	10 (100.0)	19 (100.0)	11 (100.0)

Figures in the parentheses represent percentage to respective total.

5.10 Food security index

Many authors have measured food security through various coping strategies and there are many indicators, which take into account, the resource availability, income and consumption and the adaptive ability of farms to the food insecure conditions. In the present study, five important coping strategies were identified as food security indicators based on the response of the sample households. The various coping strategies like borrowing money, eating foods that are less preferred, limiting the quantum of consumption, skipping meals and going to relatives house were studied. Using the cumulative food security index, the individual coping strategies of the sample households and also a comparison between small and large farms in the adoption of the coping strategies was made. Cumulative food security index is the sum of scores of the five strategies and higher value of the food security index indicates higher level of food security. The index was used to compare the food security condition among the small and large farms during the period of food crisis.

The values of the cumulative food security index for the sample farms in the study area are presented in Table 56. It could be observed from the table that in Nagapattinam district, the cumulative food security index for the selected respondents was 41.21 and 56.2 for small and large farms respectively. Thus the results implied that the large farms were more food secured than small farms during the drought year. In Karaikal region, large farms with the cumulative food security index of 52.31 were more food secure than small farms with a cumulative index of 40. The findings were in accordance with the results of the study conducted by Maxwell (1996), which showed that the cumulative food security index for very low-income group had low value whereas, it was high for the upper income group remarking their higher level of food security. Among the coping strategies, the sample respondents in Nagapattinam district and Karaikal region, the less preferred coping strategies were limiting the quantum of consumption, skipping meals and going to relatives houses.

Table 56. Cumulative food security index for the sample respondents in the study area

Sl. No	Particulars	Nagapattinam		Karaikal	
		Small farmer	large farmer	Small farmer	large farmer
1	Borrowing food or	3.27	4.82	3.83	4.32

	money to buy food				
2	Eating foods that are less preferred	7.80	9.22	5.27	6.53
3	Limiting the quantum of consumption	9.56	12.37	9.25	12.83
4	Skipping meals	9.23	12.96	10.28	12.35
5	Going to relatives house	11.35	16.83	11.37	16.28
	Total	41.21	56.20	40.00	52.31

5.11 Demand analysis

Food production and consumption have their influence on each other. An adequate effective demand for food is essential to sustain the growth in food production. The consumption parameters provide necessary information on linkages from food consumption and its influence on agricultural production, through the marketing sector. The availability of commoditywise disaggregated food demand parameters are essential in formulating crop diversification policies and programs (Ahmed and Shams, 1994).

Almost Ideal Demand System (AIDS)

The primary data collected from the sample respondents were subjected to AIDS analysis and separate models were run for sample farms during normal and drought periods for Karaikal region of Pondicherry U.T and for Nagapattinam district. The information collected on household food expenditure and demographic variables were used for the estimation of AIDS. The food groups included for the analysis were rice, wheat, pulses, oils and sugars, fruits and vegetables and milk that aggregated to eight food items. These food items were identified based on the consumption pattern of the sample households. Total expenditure on food and non-food items were used as a measure (proxy) of income variables in the food demand system. Household expenditure on the selected food items as a fraction of total food expenditure was arrived as household specific food budget share. Household size was the only demographic variable used in the model rather than the number in selected households; number of consumption units in a household was taken to gain accuracy, since the model relates to the demand of food products. In AIDS model the average

budget shares were linearly related to composite food prices, real per capita food expenditure and household size. The model was estimated by imposing, adding up, homogeneity and symmetric conditions. The elasticities of own price, cross price, income and household size derived from the parameter estimates of AIDS, were the key policy variables as far the study is concerned.

The statistical significance of the estimated parameters suggested that food demands were responsive to prices, the total food expenditure level and size of the households. The nature of the demand for food commodities were derived directly from the significance of the parameter estimates of AIDS model. Since the elasticities of demand are independent of the units in which demand is measured, elasticities are more meaningful measures of the responsiveness of demand to change in prices. Commodities with negative β's (expenditure parameters) are income inelastic and those with positive β's are income elastic. Similarly, commodities with positive own price parameters are price inelastic and those with negative are price elastic. The results obtained from AIDS model were (i) Parameter estimates and (ii) Elasticity estimates

5.11.1 Estimated parameters of AIDS model in Nagapattinam district - normal period

The estimated parameters based on the AIDS model for major food items for normal period are presented in Table 57. It could be seen from the table that the food items like rice, pulses, oil, sugar and vegetables had negative expenditure coefficient reflecting their income inelastic nature. Thus, any change in the income of farm households they would invariably not spend on fruits and milk. The income inelastic goods of rice, pulses, oilseeds and sugar showed positive household size coefficient and also significant depicting their increase in expenditure share of these items when household size increases. The own price parameters of pulses, fruits and vegetables, sugars had positive sign while others showed negative value indicating that the sample households would change their demand with respect to the changes in prices of pulses, fruits, vegetables and sugar. As far as the cross price parameters are concerned the share of oils was significantly influenced by price of pulses but there

was also negative significance existing between fruits and pulses, vegetables and pulses.

5.11.2 Elasticities of price, income and house hold size for normal period

The demand elasticities derived from the AIDS parameters for Nagapattinam district under normal period is depicted in Table 58. It is evident from the table that the own price elasticities for all commodities were negative which are in conformity with the basic principles of the theory of demand. For most of the food items like pulses, oils, fruits and vegetables, the estimated own price elasticities were less than unity. Rice, wheat, sugar and milk had own price elasticities exceeding unity with negative sign. Among the food items, fruits were the least responsive to changes in its own price because the price fluctuation of fruits was less. Among the cross price elasticity for different commodities, the most of products were classified as cross complements (having negative value).

Cross substitute exhibited between wheat and rice in wheat equation and also expected the cross price elasticities between oils and fruits, oils and sugars, milk and oil, milk and fruits were found to be positive which implied that they were substitutes. The cross price elasticity between most of the food items was exceeding unity. The highest positive value was observed in case of milk and oils, which implied that they were the most complementary items among the group of food items. The income elasticities for rice was less than unity showing that the rice was income inelastic and the same was observed in the case of pulses, oils, milk and vegetables. The income elasticity was more than unity for wheat and fruits, which implied their responsiveness to changes in income. Household size elasticities for rice, wheat, oils and sugar had positive effect implying that they were staple food of the sample respondents. The income inelastic good, which had negative household size elasticity were pulses, fruits and vegetables indicating thereby that they were not stable food of the sample farms.

5.11.3 Estimated parameters of AIDS Model in Nagapattinam district for drought period

The parameters estimates of AIDS model for major food items under drought period for sample farms in Nagapattinam district are presented in Table 59. The estimated parameters were found to be statistically significant for majority of food items. The expenditure co-efficient for rice, pulses and milk would change, with an increase in the real income, and others held constant. The expenditure coefficient were found to be negative for rice, wheat and milk indicating their income inelastic nature whereas the expenditure coefficient was positive for pulses, oils, sugar, fruits and vegetables indicating their income elastic nature. So the sample farms inclined to spend their incremental income on pulses, oils, sugars, fruits and vegetables in drought year. The household size coefficients were positive and significant for rice and pulses, indicating that any increase in the household size would increase the expenditure share on these items in the total expenditure share. The household size coefficients were negative for vegetables, milk, and oils implying that any increase in the household size would decrease the expenditure share of these items.

In the rice equation, with the exception of pulses and vegetables, none of the price coefficient was found to be significant. Pulses and vegetables in rice equations were negative. One percent increases in the price of pulses and vegetables would affect the share of rice by 0.04 and 0.04 per cent respectively.

5.11.4 Elasticities of price, expenditure and household size for drought period

The demand elasticities derived from the AIDS parameters under drought condition for the selected farms in Nagapattinam district is given in Table 60. The own price elasticities for all commodities were negative except for fruits, sugar and milk, since the changes in own price would have adverse impact on the demand for these items. For most of the food items like rice, wheat, oils, pulses, and vegetables the own price elasticities were less than unity. It was more than unity for milk. Among the food items, fruits were the least responsive to changes in its own price. Among the cross price elasticities for different commodities, most products were classified as cross complements (having negative value). Cross substitution exhibited between wheat and rice in wheat equation and cross price elasticities between fruits and sugar, fruits and vegetables, oils and sugar, sugar and vegetables were found to be positive which implied that they were substitutes. The cross price elasticities between

most of the food items were exceeding unity. The higher value was observed in the case of milk, wheat and milk and sugar and milk, which implied that they were the most complementary items among the group of food items. The income elasticity for rice was less than unity showing that rice was income inelastic and the same was observed in case of milk. The income elasticity is more than unity for wheat, pulses, vegetables, fruits, and oils, sugar that implied their responsiveness to changes in income. Household size elasticities for rice and milk was found to be positive implying their staple nature. The income inelastic good, which had, negative household indicating that they are not staple food for the sample households in drought condition.

Comparison of consumption pattern of food items between normal and drought period in Nagapattinam district

The comparison of elasticities derived from the demand model for normal and drought year would throw some light on changes in composition pattern of selected farms between the two periods. In Nagapattinam district, the own price elasticities of food items showed negative signs with high value during the normal period revealed the basic principles of the theory of demand. During the drought year, own price elasticity was positive for fruits and sugar showing that changes in own price will have adverse impact on the demand for these items and it would lead to decrease in consumption of fruits and sugar of the sample respondents. During the normal year, fruits were the least responsive to changes in its own price.

The cross price elasticities of food items during the normal year indicated that many food items were complementary such as oils and vegetables, sugar and oils, sugar and pulses, fruits and milk. But the components of the complementary commodity basket had been changed altogether during drought period. The components were wheat and pulses, milk and sugar, fruits and milk, oils and milk.

In both the periods, the income elasticity of rice was inelastic indicating that rice was the staple food for both the periods. The income elasticity changed from inelastic to elastic during drought period for pulses, oils and vegetables. The results showed that the sample respondents in both the periods were much concerned with consumption of rice and milk not with pulses, oils and vegetables. This would alter

the status of nutritional security of the sample respondents since the reduction in income reduces the consumption of pulses, oils, vegetables and fruits, depriving of proteins, vitamins, minerals and fat.

5.11.5 Estimated parameters of AIDS model in Karaikal region - normal period

The parameter estimates of AIDS model for major food items for the sample respondents in Karaikal region are presented in Table 61. The structural parameter estimates were of interest for technical comparisons, as number of estimated parameters were statistically significant for majority of the food items. The expenditure coefficient was found to be significant for rice, pulses, oils and milk thus revealing the fact that the expenditure share on rice, pulses, oils would change with an increase in real income with its prices held constant. The expenditure coefficients for rice, wheat, pulses and vegetables were negative indicating their income inelastic nature whereas the expenditure coefficient for oils, fruits, milk and sugar showed positive value indicating their income elastic nature. So sample households inclined to spend their incremental income on oils, milk fruits and sugar in normal year.

The household size coefficient for all the income inelastic items were positive except vegetables. The household coefficient was positive and significant for rice, pulses and milk, which indicated the fact that any increase in the household size would increase the expenditure share on these items. The household size coefficient for oils, sugar, fruits, and vegetables were found to be negative, indicating that any increase in the household size would tend to decrease the expenditure share of these goods on the total expenditure. The own price co-efficient for rice, pulses, oils, fruits and vegetables, had positive value, which indicated their price inelastic nature, and the coefficients were negative for wheat, sugars and milk which exhibited their price elastic nature.

In the rice equation, with the exception of oils, none of the price coefficients was found to be significant, which revealed that, change in the price of other food items would not influence the expenditure share of rice except oils. The price coefficient for vegetables in pulse equation was negative and significant i.e. one per cent increase in the price of vegetables would affect the share of pulses by 0.01 per cent. Similarly in oils equation also, one per cent increase in the price of pulses would

affect the share of oils by 0.14 per cent. In such a way the results of this model can be interpreted for different food items.

5.11.6 Elasticities of price, income and household size - normal period

The demand elasticities derived from the AIDS parameters for Karaikal region are provided in Table 62. It is evident from the table that the own price elasticities for all the commodities were negative which were in conformity with the basic principles of the theory of demand i.e. changes in own price indices had inverse impact on quantities demanded. For most of food items like rice, oilseeds, fruits, and vegetables the estimated own price elasticity was less than unity. The own price elasticities of wheat, pulses, sugars and milk exceeded unity. Among the food items, vegetables were least responsive to their own price.

Cross substitution exhibited between wheat and rice and also between sugar and pulses was on the expected line, which showed that these items were substitutes. The same trend was found for milk and fruits and also between milk and vegetables. The cross price elasticity between most of the food items and oils were exceeding unity. The higher value was observed in case of vegetables and oils, rice and milk, wheat and milk and sugar and milk, which implied that they are the most complementary items among the food items. Regarding income elasticity, the income elasticity for rice was less than unity showing that the rice was income inelastic and the same was observed in case of pulses, oils, milk and vegetables. The income elasticity was more than unity for wheat, which implied its responsiveness to change in income. The household elasticity size has the opposite effect of income on food demand. The household size elasticities for rice, oils and milk had positive effect implying the staple nature of these items of sample households. The household size elasticities for all the income elastic food items had negative effect. The income inelastic good, which had negative household size elasticity were wheat, pulses revealing that they were not the staple food of sample households. For example, one per cent increase in household size would increase the demand for rice by 1.24 per cent and would decrease the demand for wheat, pulses and milk by 0.25, 1.18 and 1.95 per cent respectively.

5.11.7 Estimated parameters of AIDS model in Karaikal region - drought period

The parameter estimates of AIDS model for major food items in drought period for the sample farms in Karaikal region are presented in Table 63. Most of the estimated parameters were found to be significant. The income parameter was found to be significant for rice, pulses, oils and milk implying that any increase in the real income, the expenditure share will also change. It was found to be negative for rice and wheat indicating their income inelastic nature whereas the same was positive for pulses, oils, sugars, fruits, vegetables and milk in drought year. The household size parameter was positive and significant for rice and pulses indicating that any increase in the household size would increase the expenditure share on these items in the total expenditure share. The household size parameter was negative for oils, vegetables and milk implying that any increase in the household size would decrease the expenditure share on these items. Among the own price parameters, rice, pulses, vegetables, milk, showed positive values indicating their price inelastic nature and fruits, sugar, oils showed price elastic nature.

In the rice equation, with the exception of pulses, none of the price coefficients were found to be significant. But pulses in rice equation was negative i.e. one per cent increase in the price of pulses would affect the share of rice by 0.05 per cent. Similarly in oil equation, vegetables were found to be negative but significant. This implied that one per cent increase in the price of vegetables would decrease the share of oil by 0.07 per cent. All other equations are also interpreted in the same way.

5.11.8 Elasticities of price, income and household size in Karaikal region - drought period

The demand elasticities for Karaikal region during the drought condition derived from the AIDS parameters are presented in Table 64. The own price elasticities for all the food items had shown negative signs except for vegetables since the changes in own price will have adverse impact on the demand for vegetables. The own price elasticities of rice, pulses, oils, fruits and vegetables were less than unity and for wheat, sugar it was more than unity. Among the food items vegetable was least responsive to its own price.

Among the cross price elasticities in rice equation, the cross price elasticity between rice and wheat was found to be positive indicating their substitutability nature. In pulse equation, the cross price elasticity between pulses and wheat, pulses and fruits, pulses and vegetables were positive and hence they were substitutes. The cross price elasticity between sugars and milk showed higher value indicating their highly complementary nature. The cross price elasticity of few food items was exceeding unity. The higher value was observed in case of sugar and milk, sugar, fruits and milk and Vegetables and milk, rice and milk and sugar and oils, which implied that they were the most complement items. The income elasticity for rice was less than unity showing that the rice was income inelastic and the same was observed in the case of milk and wheat. The income elasticity was more than one for vegetables, fruits, oils and pulses that implied that they were highly responsive to changes in income. Household size elasticity for rice and milk had positive effect implying that staple nature for the sample households. The income inelastic good, which had negative household size elasticity, were wheat, pulses, fruits and vegetables indicating thereby that they were not staple food for sample households.

Comparison of consumption pattern of food items between normal and drought period in Karaikal Region

The comparison elasticities derived from AIDS model for normal and drought period would reflect the reality in food consumption pattern of selected households in Karaikal region. In the case of own price elasticity of food items, which showed negative signs with high values during the normal period revealed that the law of demand was in operation without any violation. During the drought period, the own price elasticity for vegetables was positive showing that the change in price of vegetables led to decrease in consumption and there by reducing the nutritional security of the sample respondents. During the normal period, vegetable was the least responding food item to the changes in its own price.

The cross price elasticities of food items during the normal period indicated that many goods were complementary such as vegetables and oils, oils and milk, oil and sugar and sugar and milk. However, the components of complementary commodity basket have been changed altogether during drought period. The

components were wheat and vegetables, milk and sugar, fruits and milk and vegetables and milk. Both the periods, the income elasticity of rice was inelastic, indicating that rice was the staple food for the two periods. The income elasticity was changed from inelastic to elastic during drought period for pulses, oils and vegetables. The results showed that the sample respondents were much concerned with consumption of rice and milk not with pulses, oils and vegetables.

5.12 Survival strategies adopted by farm households

Farmers coping strategies against drought and uncertainty of rainfall are not just confined to activities during the drought period. Households employed a wide variety of strategies to mitigate the effects of drought on their total real income and thereby on food and livelihood security. The various drought coping strategies followed by the sample farms are discussed below.

5.12.1 Income diversification

One of the major strategies adopted to sustain households against any shortfall in return from crops was to diversify income-generating activities. Sustenance income implies the total inflow of cash or kind including borrowings during the drought year. The various sources of households' income during drought and normal year are furnished in Table 65.

The composition of household income for the selected respondents in Nagapattinam district revealed that there existed differences in the adjustment pattern of small and large farms. During the normal year, crop and livestock were the two major sources of income in both the category of farms in the study area. Apart from these two sources, small farms were also worked as wage labourers in other's fields. Wage earnings constituted 16.19 per cent of the total household income in small farms and 2.19 per cent in large farms in the normal year whereas in drought year it was 10.56 per cent and 3.22 per cent in small farms and large farms respectively.

Table 65. Average annual income of sample farms in Nagapattinam district

(Rs/year)

Sl. No	Source	Normal year		Drought year	
		Small farms	Large farms	Small farms	Large farms
1	Crop	15206.28 (42.44)	25809.68 (55.16)	2928.32 (13.29)	8248.26 (28.73)
2	Livestock	5237.86 (14.62)	9268.60 (19.83)	1838.38 (8.34)	4825.76 (16.81)
3	Agricultural labour	5800.23 (16.19)	1023.00 (2.19)	2328.17 (10.56)	923.50 (3.22)
4	Non-agricultural job	1816.00 (5.07)	2578.32 (5.53)	1989.23 (9.03)	2200.36 (7.66)
5	Migration	-	-	3257.00 (14.78)	2800.00 (9.75)
6	Relief fund	-	-	2500.00 (11.34)	2500.00 (8.71)
7	Transfers from other sources	1539.00 (4.30)	2239.34 (4.79)	2873.00 (13.04)	3339.31 (11.63)
8	Others	6230.38 (17.38)	5870.27 (12.5)	4325.85 (19.62)	3872.37 (13.49)
9	Total	35829.85 (100.0)	46789.21 (100.0)	22039.95 (100.0)	28709.56 (100.0)
10	Per capita income at current price	587.37	1613.42	361.31	1058.95

Figures in the parentheses represent percentage to respective total.

Transfers, which included sale of livestock and other movable assets, help from relatives, borrowings etc., were the next major source of income for the farms who were in the drought condition and constituted 13.04 per cent in small farms and 11.63 per cent in large farms in drought year. In normal year, it constituted 4.30 per cent and 4.79 per cent for small and larger farms respectively. During drought year, non-agricultural job constitutes 9.03 per cent and 7.66 per cent to the total households income in small and large farms respectively. The other earning activities constituted less than 20 per cent of the total household income. Crop and livestock contributed 13.29 and 8.34 per cent for small farm and 28.73 and 16.81 per cent in large farms respectively to the total households income during drought year. Whereas in normal year, it contributed 42.44 per cent and 14.62 per cent in small

farms, and 55.16 and 19.83 per cent in large farms respectively. In large farms, crop followed by livestock and transfer were the major income sources. During the drought year in the small farms, income from migration and transfer accounted for the largest proportion of sustenance income. Migration in search of jobs to places like Kerala to work in the construction sector at the wage rate of Rs 100 / day during off-season was also observed. Relief works in the form of drought relief fund given to the farms, constituted a share of 11.34 and 8.71 in small and large farms respectively.

The average annual income of the sample farms in Karaikal is given in Table 66. The table revealed that crop and livestock sector constituted 10.87 per cent in small farms and 26.39 per cent in large farms of the total household income during drought year. Whereas in normal year, the crop and livestock sector contributed higher share to the total household income. Mostly small farms worked as agricultural labourers. Agricultural wage earnings had declined in drought year when compared to normal year, because of the non-availability of water. The non-agricultural jobs constituted about 9.81 per cent in small farms and 8.16 per cent in large farms of the total household income in drought year. Migration and relief works were not taken place in normal season but in drought year, they accounted for 13.25 and 8.68 per cent to the total household sustenance income in the case of small farms. The large farmers were also getting relief to the tune of 5.25 per cent of their total income. They also migrated in search of jobs and the share of income from this category was 7.06 per cent during drought year.

Drought relief fund was given to the farms due to crop failure. Transfer accounts for a larger proportion of sustenance income of about 12.15 per cent in small and 17.15 per cent in large farms during drought. Farms were able to derive sustenance income through disposal of assets and borrowing because of their better asset position and higher credit worthiness.

Table 66. Average annual income of sample farms in Karaikal region (Rs/year)

Sl. No	Source	Normal year		Drought year	
		Small farms	Large farms	Small farms	Large farms
1	Crop	12826.08 (39.36)	20859.23 (51.58)	2316.28 (10.87)	7531.25 (26.39)
2	Livestock	6327.85 (19.42)	8579.26 (21.22)	2238.35 (10.51)	5381.76 (18.86)
3	Agricultural labour	4525.36 (13.89)	1359.36 (3.33)	2525.38 (11.85)	867.32 (3.04)
4	Non-agricultural job	1987.15 (6.10)	2879.17 (7.12)	2089.17 (9.81)	2328.18 (8.16)
5	Migration	-	-	2823.19 (13.25)	2013.65 (7.06)
6	Relief fund	-	-	1850.36 (8.68)	1500.81 (5.25)
7	Transfers from other sources	1238.32 (3.79)	1980.39 (4.00)	2587.82 (12.15)	4895.32 (17.15)
8	Others	5682.95 (17.44)	4780.32 (11.82)	4875.35 (22.88)	4022.38 (14.09)
9	Total	32587.71 (100.0)	40437.73 (100.0)	21305.92 (100.0)	28540.66 (100.0)
10	Per capita income at current price	1629.38	4043.773	1065.29	2854.0

Figures in the parentheses represent percentage to respective total.

Income from livestock to the total annual income reduced during drought year when compared to the normal year because of acute fodder shortages. So the large farms sold their livestock in order to combat the drought. Less than five per cent of the sample households earned income from livestock and abandoned farming. Government drought relief fund in the form of cash was given to the farms due to the crop failure at the rate of Rs. 1000 per acre and the fair price shop had been providing an extra supply of 5 kg rice to the farms. Sometimes government supplied the packed food to the drought-affected farms.

On an average, the income of the households decreased by 38.48 per cent in Nagapattinam district and 34.62 per cent in Karaikal region in the case of small farms. It was 34.36 and 29.42 per cent decline in income for large farms in Nagapattinam district and Karaikal region respectively. The per capita sustenance income had

declined in the drought year than the normal year. Thus, there existed difference in the degree of income diversification across the regions.

Following findings were emerged from the above results. In the event of a drought, farms tried to compensate their reduced income through non-crop sources like sale of livestock, assets, farm equipments, jewels, wage earnings and non-agricultural wages. The average share of non-crop income was 86.71 per cent in small farms and 73.14 per cent in large farms in Nagapattinam district. In Karaikal region, it contributed 89.13 per cent in small farms and 73.61 per cent in large farms.

5.12.2 Migration

Seasonal migration is a traditional device adopted by households to cope with local drought situations. Migratory income occupied a large share in the sustenance income in both categories of farms during drought season. Details on the number of farms migrated among the sample farms and reasons for migration are furnished in Table 67. It could be seen from the table that 14.44 per cent of the small farm households and 8.89 per cent of the large farm households to the total farm households resorted to temporary migration in Nagapattinam district. The incidence of migration was more in small farms than in large farms. About 16.69 per cent of small farms and 8.89 per cent of the large farms had migrated in search of employment. The proportion of dependents among the sample respondents was 5.56 per cent in small farms and 4.44 per cent among large farms. But it was difficult for the small farms to have their dependents in the village and support them during the drought period. Large farms can travel longer distances than small farms seeking employment in the other regions.

In Karaikal region, about 30 per cent of small farms and 20 per cent of large farms to the total sample households reported temporary migration in different regions. The incidence of migration was more among small farms than among large farms. About 26.67 per cent of the small farms and 16.67 per cent of the large farms to the total sample respondents had migrated in search of employment. Only 3.33 per cent and 2.22 per cent of the small and large farms were migrated for dependent members. Large farms can travel long distance to work in the construction and quarrying sector and they were paid Rs 100 per day, sometimes small farms were also

migrating to other villages to work in the field or in any construction sector, where they were offered Rs 60-75 per day during the off-season. So migration could be reduced by encouraging off-farm activities like animal husbandry, poultry *etc.,* in these areas.

5.12.3 Asset disposal

Assets disposal was the major component of non-crop income. It is another management device adopted by small and large farms to supplement the households income during the drought year. There were three types of assets disposal like farm assets, home assets and livestock assets. The depletion of assets was more severe in the case of productive assets like livestock. This could greatly affect the production potential in terms of draught power, milk, and fuel *etc.,* Details on the assets disposal pattern of sample farms is given in Table 68.

Table 68. Average value of assets disposal of the sample farms during drought year (Values in 000's)

Sl. No	Details	Nagapattinam district		Karaikal region	
		Small farms	Large farms	Small farms	Small farms
1.	Farm assets (farm implements, machinery)	4.6 (34.85)	7.3 (30.54)	3.9 (27.46)	5.6 (26.54)
2.	Livestock assets (drought, milch, sheep, goat)	6.3 (47.73)	7.9 (33.06)	4.2 (29.58)	7.5 (35.55)
3.	Home assets (jewellery, vessels, bicycle, vehicles)	2.3 (17.42)	8.7 (36.40)	6.1 (42.96)	8.0 (37.91)
4.	Total	13.2 (100.00)	23.9 (100.00)	14.2 (100.00)	21.1 (100.00)

Figures in the parentheses represent percentage to respective total.

It could be seen from the table that the major portion of assets disposed by small farms were livestock (47.73 per cent) followed by farm and home assets by 34.85 percent and 17.42 per cent respectively of the total value of assets in Nagapattinam district. In case of large farms, livestock assets were disposed to tune of 33.06 per cent of the total value of assets. The major asset disposed by the large farms

was home asset by 36.40 per cent of the total asset value. In Karaikal region, the major assets disposed by the small farms were home assets (42.96 per cent) followed by livestock assets by 29.58 per cent and farm assets by 27.46 per cent. In case of large farms, the major assets disposals were home assets (37.91 per cent) and farm assets by 26.54 per cent of the total value of assets. The depletion of assets during drought year particularly of productive assets like livestock and farm machinery reduced the capital formation and hence they were forced to borrow money for resuming the farm activities.

5.12.4 Credit borrowings

During the drought year, the major sources of credit for small farms were large farms followed by moneylenders. Small farms can easily access the money from the moneylenders. But they were charging usurious rate of interest. Traders and institutions were the major source of credit for the large farms. Details of borrowings by households during drought year are given in Table 69. In Nagapattinam district, small farms borrowed 45.73 per cent money from large farms followed by private jewel loans to the tune of 10.59 per cent and from relatives by 15.85 per cent. Moneylenders played a major role in providing credit to the farms. They provide credit to the small farms by 27.83 per cent of their requirement. In case of large farms, traders constituted a major share of providing 45.42 per cent of their credit requirement. Institutions like cooperatives and commercial banks were also supplying credit (23.28 per cent) to large farms.

In Karaikal region, large farms constituted 48.30 per cent, which was the major source of credit for the small farms followed by moneylenders of 34.82 per cent. In case of large farms, traders and jewel loans constituted a major share of 36.88 per cent and 32.27 per cent respectively of the total borrowings.

In both the regions, most of the credit borrowed was for consumption purpose and this discouraged lending by institutional agencies. Most of the small farms cannot have access to institutional credit because of their complex rules and regulations. Farms could not get the money immediately. So the small farms prefer moneylenders due to easy access. Hence, institutional credit accounted for a very small proportion of the total borrowings and the moneylenders play a vital role. Due to the risky nature of

lending credit during drought years, cost of credit became very high. The small farms were forced to borrow at higher interest rate because of their lower credit worthiness.

5.12.5 Deferment of social and religious obligations

About 30 per cent of the small households in both the regions were postponed marriages during drought year. Mostly small farms postponed social and religious ceremonies during drought year when compared to the normal year. About 35 per cent in Nagapattinam district and 20 per cent in Karaikal region did not celebrate any religious festivals either due to non- availability or lack of capital. Only a few percent of the sample respondents had belief with the goddess of rain in performing the function. This function was celebrated as a village ceremony with the belief that the god would bring rain and prevent them from facing hardship such as drought and famines in future.

CHAPTER VI

SUMMARY AND CONCLUSION

A brief summary of the salient findings of the study is presented in this chapter. The general objective of this study is to assess the impact of drought or water scarcity conditions and to identify the survival strategies of the farm households in the tail end region of Cauvery delta zone. Even though technological advancement in agriculture sector tremendously increased the scope of commercialization, but the weather factors, especially rainfall plays truant in agriculture. The result of monsoon failure or no release of water in Cauvery river made havoc in this region for the past three years successively.

To know the impact of water scarcity conditions on the farm economy of this region, this study was carried out in Nagapattinam district and Karaikal region of U.T of Pondicherry. The data were collected from 90 farms in nine villages of Sembanarkoil block in Nagapattinam district, with a larger area under paddy and canal as the major source of irrigation. Thirunallar commune in Karaikal region was purposively chosen in which 30 farm households were selected randomly from three villages with larger area under paddy. The ultimate sample size was 120.

The data collection was undertaken during the months of May and June 2004. Data were collected from the sample respondents for the drought year 2003-2004 to study the farm level consequences of drought. For the purpose of comparative analysis between drought and non-drought years, data were also collected from the respondents for the normal year 2000-2001 also. Therefore, the reference years for the study were 2000-01 (normal year) and 2003-04 (drought year).

To address the proposed objectives of the study, data were collected from both the primary and secondary sources. Primary data on age, education, household size, land use pattern, cropping pattern, yield, cost of cultivation, employment, income and expenditure pattern of sample farms were collected through a well structured and pre-tested interview schedule by survey method. To know the impact of drought, similar data were collected for the normal year also by recall.

Salient findings

General characteristics of the sample households

The general characteristics of the farm households would give an idea about the socio-economic position of the sample farms. Decision makers of the farms in the sample were found to be educated upto primary level. The average household size was found to be five in Nagapattinam district and six in Karaikal region. The age distribution of households indicated the fact that majority of the heads of the households were in the age group of 36-45 years in Nagapattinam district and more than 45 years in Karaikal region. Educational level of the sample respondents taken for the study indicated that majority of the farms had completed their primary schooling. The illiteracy level was found to be nine per cent in Nagapattinam district and 13.3 per cent in Karaikal region.

In Nagapattinam district, the average size of land holdings was 1.13 ha in drought year and 1.23 ha in normal year. However, in Karaikal region, it was 1.19 ha in both drought and normal years. Wetlands occupied a predominant share in both the regions. The total wetland area in the sample farms in Nagapattinam district was119.60 and 117.09 ha in drought and normal year respectively. Whereas in Karaikal region, it was 44.5 and 39.6 ha. The share of area owned in total wetland area was 65.82 per cent in drought year to 75.11 per cent in normal year while that of garden land did not show any difference in drought and normal year in Nagapattinam district. While in Karaikal region, the total area owned under wetland was 68.76 and 78.79 per cent respectively in drought and normal seasons.

The asset position of the selected farms indicated that land was the major asset and accounted for 69.47 per cent and 85.92 per cent of the total asset value of households in Nagapattinam district and Karaikal region respectively. The average value of total assets in Nagapattinam district was Rs. 3,45,450 whereas it was Rs.1,28,020 in Karaikal region. Thus, in general there existed wide variations in asset position between these two regions.

Canals and borewells were the major source of irrigation, which together account for more than 60 per cent of the gross irrigated area. In Nagapattinam district,

area irrigated by canal formed the largest share of 64.25 per cent and by borewells 35.75 per cent. In Karaikal region, majority of the area in sample farms was irrigated both by borewells and canals.

The cropping pattern followed by the sample farms in the study area indicated that paddy was the major crop and it occupied a share of 65.63 per cent to the total gross cropped area in normal year whereas in drought year it was 59.78 per cent in Nagapattinam district. The higher percentage decline was noticed in paddy, which accounted for 42.03 per cent. In the event of drought, the gross cropped area declined over the normal year by about 36.36 per cent in Nagapattinam district. In Karaikal region, paddy showed a decline of 15.18 percent over the normal year. The gross cropped area declined by 2.61 per cent in drought year when compared to normal year. Majority of the respondents followed paddy-paddy-pulses rotation in normal year, whereas during drought year most of them followed paddy – pulses rotation, paddy only, paddy-cotton etc., and the land was left as fallow in the III season in the study area.

Instability in yield

Coefficient of variation (CV), Probability of Crop failure (PCF), and Crop loss ratio (CL) were the indicators used to examine the nature, extent and magnitude of instability in yield of paddy in all the three seasons for the period from 1972-73 to 2001-02 for Karaikal region and 1992-93 to 2002-03 for Nagapattinam district.

In both the regions, CV_t was highest in third season crop, followed by first season kuruvai paddy crop. Samba had the lowest (CV_t). It was generally expected that crops occupying a larger percentage of gross cropped area have lesser variability in yield. Among the paddy crop season, II season *i.e.* samba paddy covering larger area (83.18 per cent) had lesser CV_t, of 15.21 per cent in Karaikal region and 13.23 per cent in Nagapattinam district. This implied that farms grow the paddy crops that have lesser variability in season to meet the uncertainty in water scarcity condition. Among different seasons, farms were found to allocate more area to paddy during the second season with assured irrigation.

In Nagapattinam district, PCF was highest in third season paddy crop (0.35 per cent), followed by first season paddy crop by 0.32 percent and lower in second season paddy (0.28 per cent). In Karaikal region, PCF was maximum in first and third season paddy crop (0.3 per cent) and slightly lower in second season (0.27 per cent). Between the first two seasons, kuruvai has the higher probability of crop failure than samba paddy

The extent of crop failure examined by the Crop Loss (CL) ratio indicated the magnitude of crop-loss beyond 10 per cent of the trend estimate in relation to the normal average yield for the period. In Nagapattinam district, third season paddy had the highest CL ratio of 35.22 followed by first season with the ratio of 28.32. The first season had the highest CL ratio of 23.14 in Karaikal region and other seasons had lesser ratios than the first season paddy.

The instability indices pointed to a higher variability in second season when compared to first two seasons in both the study areas. Temporal instability was studied by examined the sequence of years with below normal average yield. The findings revealed that prevalence of low yield for one, two and more than four years in succession was a common incident among the three seasons in paddy crop in both the regions.

Coefficient of variation

The coefficient of variation of area, production and productivity of paddy crop was worked out for a period from 1992-93 to 2002-03 (11 years) in Nagapattinam district and from 1972-73 to 2001-02 (30 years) for Karaikal region. The CV for area, production and productivity of paddy ranged from eight per cent to 58 per cent. In Nagapattinam district, CV for area varied from 7.74 per cent for second crop to 26.10 per cent in the case of first crop. In case of production, CV ranged from 30.10 per cent to 57.58 per cent and the instability was found to be the least for first season. Among the instability in area, production and productivity of paddy, CV for production was found to be the maximum in third and first seasons while the instability in productivity was the highest for the second crop. It could be concluded that the instability in production in Nagapattinam district was mainly contributed by instability in productivity rather than area.

In Karaikal region, the instability in area, production and productivity was found to be maximum in third season. While area contributed more to instability in production in first and third seasons, while productivity was the major reason for instability in production, which was higher in first and third seasons.

Impact of rainfall on crop yields

The impact of rainfall on crop yields was estimated through linear regression model. The results implied that the average rainfall and volume of water release in the first season crop and rainfall and irrigated area in the second season crop were the major factors influencing variation of crop yield from the mean level in Nagapattinam district. In first season, every increase in the release of water increased the yield i.e one tmc increased release of water increased the paddy yield by 27.01 kg/ha. Whereas in Karaikal region, rainfall in first season crop and rainfall, irrigated area in the second season crop were the major factor influencing variation of crop yield in Karaikal region. The coefficient of multiple determinations (R^2) was statistically significant in all the equations implying that the explanatory variables included in the model had significant influence on crop yield.

Cost of cultivation of paddy

The cost of production of paddy was estimated for drought year and normal years in Nagapattinam district and Karaikal region. In Nagapattinam district, the total cost of production of paddy crop was calculated as Rs. 17555.81 and Rs. 13173.85 respectively per ha for normal year and drought year. The share of variable cost and fixed cost to the total cost of production was about 68.81 and 31.19 per cent for normal year while it was 65.39 per cent and 34.61 per cent in drought year. The gross income, gross margin and net income were declined by 32.91 per cent, 37.25 per cent, and 55.09 per cent respectively in drought year when compared to the normal year.

In Karaikal region, the total cost of cultivation per ha of paddy was estimated at Rs.17520.83 and Rs. 15313.51 for normal year and drought year respectively. The share of variable and fixed cost to the total cost of production was about 70.96 per cent and 29.04 per cent in normal year and 69.35 per cent and 30.65 per cent in drought year. The decline in gross income, gross margin and net

income obtained during normal year was 28.49 per cent, 44.49 per cent and 78.05 per cent respectively while comparing the same during normal year.

Eventhough a substantial decline in share of various operations in total cost was not found, the absolute cost of almost all the operations declined significantly in drought year making the decline in cost of cultivation by 24.96 per cent in Nagapattinam district and 12.60 per cent in Karaikal region. The result implied that inputs used for the cultivation of paddy crop was declined in drought year when compared to the normal year.

Pattern of employment and income distribution

The number of mandays of employment in a month varied significantly in the drought year and the normal year. On an average, for the sample respondents as a whole in Nagapattinam, the number of days employed per month was 15.99 in drought season and 22.44 mandays in normal year whereas in Karaikal region, the average number of days employed was 18.93 and 23.59 mandays in drought and normal years respectively. The result indicated that employment opportunities were reduced by 28.74 per cent in Nagapattinam district and by 19.75 per cent in Karaikal region during drought year when compared to the normal year.

On-farm and non-farm activities were the major sources of employment during the normal year. In the event of drought, there was a change in the occupational structure of farms in the regions. In Nagapattinam district, the on-farm employment declined by 38.03 per cent during drought when compared to the normal period. The off-farm and non-farm employment had increased by 4.65 per cent and 48.91 per cent respectively during the drought period. The reduction in total employment per annum was 11.36 per cent due to drought.

In Karaikal region, the reduction in employment generation was 7.39 per cent. The reduction in on-farm employment (36.21 per cent) has been compensated by the generation of employment in non-farm by 67.72 per cent. Due to drought, the average income of the sample households reduced by 31.58 and 30.73 percent respectively in Nagapattinam district and Karaikal region. The reduction in on-farm income has been

compensated by non-farm income by 127.80 per cent in Nagapattinam district whereas in Karaikal region, it was 117.73 per cent.

Household consumption pattern

The consumption expenditure on food as well as non-food items is a direct function of income and varies among different categories of households. The consumption expenditure of food and non-food items indicated that expenditure varied considerably between the small and large farm during normal and drought years. In Nagapattinam district, the decline in consumption expenditure of food items in the drought year (as compared to the normal year) was 21.69 per cent in small farms and 14.02 per cent in large farms respectively. The decline in the consumption of rice in the drought year was less when compared to fruits, oils and sugar. An increase in consumption expenditure by 19.87 and 5.68 per cent respectively in small and large farms during drought year was found only in the case of other cereals (coarse cereals and millets) in Nagapattinam district and this was due to the substitution of food items including rice with low value cereals like ragi, cumbu etc., The consumption expenditure of non food items for drought year (as compared to normal year) declined by 22.05 percent in small farms and to 14.22 per cent in large farms.

In Karaikal region, the extent of decline in consumption expenditure of food items was 22.61 per cent and 11.23 per cent respectively in small and large farms. Whereas in case of non-food items, the decline was 20.69 and 8.60 per cent. The result implied that small farms reduced their consumption level during drought year when compared to normal year in both the study areas.

Crop diversification

Herfindahl index was used to estimate the crop diversification in drought and normal years for different crop. The index of crop diversification for Nagapattinam district was 0.53 in drought year and 0.45 in normal year. This implies that there is less crop diversification in drought year when compared to the normal year. In Karaikal region, the crop diversification index was 0.7 and 0.4 in drought and normal year respectively. The result indicated that the farms are not adopting any crop diversification in the drought year when compared to the normal year.

Farm diversification

The share of different sub sectors in total income from all sources was found out and the Herfindahl index was estimated. In Nagapattinam district, a high level of farm diversification (Index value between 0.3 and 0.5) was found in the case of 54.10 per cent and 55.17 per cent of small and big farms respectively in drought year while 17.46 and 29.63 percent during normal year. This indicated that small farms diversify their income to different sub sectors when compared to the large farms in drought season. The farm diversification indices for Karaikal region also reflected the same pattern, where the small farms diversifying their income to different sub sectors.

Food security situation

Cumulative food security index developed through various identified coping strategies indicated that large farms were more food secured than small farms during drought period.

In Nagapattinam district, the cumulative food security index was 41.21 and 56.2 for small and large farms respectively. Thus, the results implied that the large farms were more food secured than small farms during the drought year. In Karaikal region, large farms with the cumulative food security index of 52.31 were more food secure than small farms with a cumulative index of 40.0. The findings were in accordance with the results of the study conducted by Maxwell (1996), which showed that the cumulative food security index for very low-income group had low value whereas, it was high for the upper income group remarking their higher level of food security.

Almost Ideal Demand System (AIDS)

To study the influence of the commodity prices, real income and household size on consumption pattern, a well known complete demand model AIDS was estimated by considering the expenditure share on each food items as the dependent variable with seven food commodity prices and household sizes as independent variable. The own price and expenditure elasticities were derived from the estimated coefficients.

The comparison of elasticities derived from AIDS model for normal and drought period would reflect the reality in food consumption pattern of selected

households in Karaikal region. In the case of own price elasticity of food items, which showed negative signs with high values during the normal period revealed that the law of demand was in operation without any violation. During the drought period, the own price elasticity for vegetables was positive showing that the change in price of vegetables led to decease in consumption security of the sample respondents.

The cross price elasticities of food items during the normal period indicated that many goods were complementary such as vegetables and oils, oils and milk, oil and sugar and sugar and milk. But the component of complementary commodity basket has been changed altogether during drought period. The components were wheat and vegetables, milk and sugar, fruits and milk and vegetables and milk. Both the periods, the income elasticity of rice was inelastic, indicating that rice was the staple food for the two periods. The income elasticity was changed from inelastic to elastic during drought period for pulses, oils and vegetables, the results showed that the sample respondents were much concerned with consumption of rice and milk not with pulses, oils and vegetables.

In Nagapattinam district the own price elasticities of food items which showed negative signs with high value during the normal period revealed the basic principles of the theory of demand. During the drought year, own price elasticity was positive for fruits and sugar showing that changes in own price would have adverse impact on the demand of these items and led to decrease in consumption of fruits and sugar among the sample respondents. During the normal year fruits were the least responsive to changes in their own prices.

The cross price elasticities of food items during the normal year indicated that many food items were complementary such as oils and vegetables, sugar and oils, sugar and pulses, fruits and milk. But the components of the complementary commodity basket had been changed altogether during drought period. The components were wheat and pulses, milk and sugar, fruits and milk, and oils and milk.

In both the periods, the income elasticity of rice was inelastic indicating that rice was the staple food for both periods. The income elasticity was changed from inelastic to elastic during drought period for pulses, oils and vegetables. The results

showed that the sample respondents in both the regions were much concerned with consumption of rice and milk not with pulses, oils and vegetables. This would alter the status of nutritional security of the sample respondents since the reduction in income reduces the consumption of pulses, oils, vegetables and fruits depriving of proteins, vitamins, minerals and fat.

Survival strategies adopted by farm households

Households employed a wide variety of strategies to mitigate the effects of drought on their total real income and hence their food and livelihood security.

Income diversification

There existed difference in the degree of income diversification across regions and farm size classes. In the study areas during the normal year, crop, livestock and wage earnings were the major sources of income in small farms and in large farms crop followed by livestock and transfer were the major income sources. In Nagapattianm district, transfer which included sale of livestock and other movable assets, help from relatives, borrowings etc., were the next major sources for the farms who were in the drought condition and constituted 13.04 per cent in small farms and 17.39 per cent in large farms in drought year, whereas in normal year, it constituted 4.30 per cent and 4.79 per cent in small and larger farms respectively.

In Karaikal region, crop and livestock sector constituted 10.87 per cent in small farms and 26.39 per cent in large farms of the total households income during drought year. Whereas in normal year, the crop and livestock sector contributed higher share to the total households income. Transfer accounted for larger proportion of sustenance income of about 13.04 per cent in small and 17.39 per cent in large farms. On an average, the income of the households decreased by 38.48 per cent in Nagapattinam district and 34.62 per cent in Karaikal region. The per capita sustenance income has also declined in the drought year than the normal year. Thus, there existed difference in the degree of income diversification across the regions.

In the event of a drought, farms tried to compensate their reduced income through non-crop sources like sale of livestock, assets, farm equipments, jewels, wage labourers and non-agricultural labourers. The average share of non-crop income

contributed 86.71 per cent in small farms and 73.14 per cent in large farms in Nagapattinam district. In Karaikal region, it constituted 89.13 per cent in small farms and 73.61 per cent in large farms.

Migration

Migratory income occupied a large share in the sustenance income in both categories of farms during drought season. About 14.44 per cent of the small farm households and 8.89 per cent of the large farm households to the total farm households resorted for temporary migration in Nagapattinam district. The incidence of migration was more in small farms than in large farms. About 50 per cent of the migrants in Nagapattinam district went out in search of employment.

In Karaikal region, about 30 per cent of small households and 20 per cent of large households to the total sample households reported for temporary migration in different regions. Large farms can travel long distance to work in the construction and quarrying sector and they were paid Rs 100 per day. Sometimes small farms migrated to other villages to work in the field or in any other construction sector, where they were offered Rs 60-75 per day during the off-season. So migration could be reduced by encouraging off-farm activities like animal husbandry, poultry *etc.*, in these areas.

Asset disposal

Assets disposal was the major component of non-crop income. It could be observed that the major portion of assets disposed were livestock (47.55 per cent) followed by farm and home assets by 34.72 percent and 17.73 per cent respectively of the total value of assets by the small farms in Nagapattinam district. In case of large farms, livestock assets were disposed by 33.03 per cent. The major asset disposed by the large farms was home asset by 36.45 per cent to the total value of assets.

In Karaikal region, the major assets disposed by the small farms was home assets (42.96 per cent) followed by livestock assets by 29.58 per cent and farm assets by 29.58 per cent. In case of large farms, the major assets disposed were home assets (38.01 per cent) and farm assets by 26.50 per cent to the total value of assets.

Credit borrowings

During the drought year, large farms were the major sources of credit for small farms followed by moneylenders. In Nagapattinam district, small farms can borrow money from large farms by 45.73 per cent of their requirement followed by private jewel loans of 10.59 per cent and relatives by 15.85 per cent. Moneylenders provided credit to the small farms by 27.83 per cent. In case of large farms, traders constituted a major share of borrowings by 45.41 per cent. In Karaikal region, large farms constitute 48.30 per cent, which was the major source of credit for the small farms followed by moneylenders of 34.82 per cent. In case of large farms, traders and jewel loans constituted a major share of 36.88 per cent and 32.27 per cent respectively of the total borrowings.

Institutional credit accounted for a very small proportion of the total borrowings and the moneylenders have higher proportion. Due to the risky nature of lending credit during drought years, cost of credit became higher. The small farms were forced to borrow at usurious interest rate because of their lower credit worthiness.

Deferment of social and religious obligations

About 35 per cent in Nagapattinam district and 20 per cent in Karaikal region did not celebrate any religious festivals due to either non-availability or lack of capital.

Policy options

- The occurrence of drought was sequential and for every seven good seasons, two or three bad seasons were found to take place. The prediction of drought with weather forecasting is essential as it will be helpful to formulate coping strategies.

- The crop loss has been severe in first and third seasons due to scarcity of water. The farms can be advised to cultivate paddy crop in second season and during the first and third seasons, less water intensive crops may be advocated.

- Drought tolerant varieties of paddy may be identified for I and III seasons.

- Direct sown paddy is highly suitable for the study area and also to save water. To create awareness among farms and popularize direct sown paddy, the extension services in the study area ought to be strengthened.

- Much scope is available for crop and farm diversification in the study area. Hence, suitable alternative cropping pattern might be evolved to diversify agriculture in the study area**.**

- There is scope for income diversification and suitable alternative enterprise plan including all sub sectors may be evolved to suit the conditions of the study area.

- Employment generation in non-farm sector is the key to absorb labour from agriculture. Proper plan is to be evolved during drought to generate employment through creation of social infrastructure in the study area.

- During drought years, with the exception of rice there is a shift in consumption pattern of staple food items towards non-staple food. To assure nutritional security, pulses, oils and fats can be distributed through fair price shops. Alternatively, the wages in employment generation programmes can have kind component portion with not only rice, but also the other food items like pulses and oils.

- Non-availability of institutional credit to the small farms was the main constraint for coping strategies to drought. Hence, proper distribution of institutional credit is essential to ease the severity of drought.

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Table 8. Distribution of operational land holding in Nagapattinam district

Sl. No.	Size range (ha)	Nagapattinam district				Sembanarkoil block			
		Number	percent to total	Area in ha	percent to total	Number	percent to total	Area in ha	percent to total
1	**Marginal farmer (<1)**	135211	74.74	53305.01	34.2	14886	75.16	5699.99	33.26
2	**Small farmer (1-2)**	37883	20.95	61915.3	39.73	4003	20.22	6539.52	38.16
3	**Medium farmer (2-4)**	5384	2.98	20430.62	13.11	576	2.91	2219.7	12.95
4	**Large farmer (>4)**	2419	1.34	20215.32	12.96	340	1.71	2679	15.63
5	**Total**	180897	100	155866.25	100	19805	100	17138.21	100

Source: District Statistical Hand Book, Nagapattinam

Table 48. Average monthly consumption expenditure on food items of the sample farms in Nagapattinam district

(Rs/month)

S.No	Crop	Small farmers			Large farmers		
		Normal	Drought	percent change	Normal	Drought	percent change
1	Rice	525.26	561.35	-10.22	685.82	601.83	-12.25
2	Other cereals	44.14	52.91	19.87	30.81	32.83	+5.68
3	Pulses	201.86	171.61	-14.99	285.85	272.37	-4.72
4	Oil and fats (cooking oils)	149.42	102.10	-31.67	268.32	221.38	-17.49
5	Sugar	42.87	28.35	-33.87	62.53	51.76	-17.22
6	Fruits	43.08	23.78	-44.80	75.67	52.68	-30.38
7	Vegetables	125.75	70.25	-44.14	224.47	191.72	-14.59
8	Milk	96.05	40.26	-58.08	127.97	102.58	-19.84
9	Others	137.05	97.02	-29.21	162.66	127.53	-21.59
10	Total	1465.48	1147.62	-21.69	1924.10	1654.41	-14.02

Table 49 Average monthly consumption expenditure on food items of the sample farms in Karaikal region (Rs/month)

Sl. No	Crop	Small farmers			Large farmers		
		Normal	Drought	percent change	Normal	Drought	percent change
1	Rice	592.17	540.27	-8.76	617.52	598.74	-3.04
2	Other cereals	52.06	43.72	-16.02	40.79	37.52	-8.02
3	Pulses	224.83	182.54	-18.81	267.77	223.32	-16.60
4	Oil and fats (cooking oils)	128.56	97.53	-24.14	197.20	156.40	-20.69
5	Sugar	49.75	23.86	-52.04	51.03	47.60	-6.72
6	Fruits	47.52	26.34	-44.57	72.52	59.03	-18.60
7	Vegetables	132.57	82.33	-37.89	212.79	194.05	-8.81
8	Milk	92.75	41.57	-55.18	143.99	120.08	-16.61
9	Others	142.76	94.02	-34.14	175.67	142.76	-18.73
10	Total	1462.97	1132.18	-22.61	1779.28	1579.5	-11.23

Table 50. Average monthly consumption expenditure on non-food items of the sample farms in Nagapattinam district

(Rs/ month)

S.No	Items	Small farmers			Large farmers		
		Normal	Drought	percent change	Normal	Drought	percent change
1	Clothing	220.76	140.07	-36.55	275.06	247.56	-9.99
2	Sheltering	102.20	93.02	-8.98	156.72	123.65	-21.10
3	Fuel	57.26	40.76	-28.82	72.06	57.76	-19.84
4	Education	75.20	70.20	-6.65	127.56	120.26	-5.72
5	Recreation	42.07	36.72	-12.72	77.56	70.50	-9.10
6	Religious and social function	81.05	62.97	-22.31	87.53	72.64	-17.01
7	Medicine	120.52	92.67	-23.11	102.54	78.04	-23.89
8	Transport	65.07	47.86	-26.45	82.54	61.04	-26.05
9	Others	72.06	67.56	-6.24	97.14	82.54	-15.03
10	Total	836.19	651.83	-22.05	1078.71	913.99	-15.27

Table 51. Average monthly consumption expenditure on non-food items of the sample farms in Karaikal region (Rs/month)

S.No	Items	Small farmers			Large farmers		
		Normal	Drought	percent change	Normal	Drought	percent change
1	Clothing	242.07	162.67	-32.80	265.00	252.60	-4.68
2	Sheltering	71.26	60.53	-15.05	162.55	151.03	-7.09
3	Fuel	61.52	47.62	-23.08	79.52	62.59	-21.29
4	Education	82.50	80.55	-2.36	97.60	90.25	-7.31
5	Recreation	54.60	47.52	-12.97	81.05	75.37	-7.0
6	Religious and social function	87.65	73.21	-16.47	93.52	81.13	-15.06
7	Medicine	127.02	110.67	-24.87	87.52	74.06	-15.38
8	Transport	72.57	54.60	-24.76	87.52	74.06	-15.38
9	Others	94.66	71.77	24.18	102.76	85.17	-17.12
10	Total	893.85	709.14	-20.66	1057.04	946.26	-10.48

Table 57. Estimated parameters of AIDS model for Nagapattinam district – normal period

Items	Constant	Rice	Wheat	Pulses	Oils	Sugars	Fruits	Vegetables	Milk	Real per capita expenditure	Household size
Rice	1.2413** (6.1713)	0.0423 (1.4857)	-0.0101 (0.8688)	-0.0387** (-3.7534)	0.0739** (2.6713)	-0.0140 (-1.2204)	-0.0053 (-0.7031)	-0.0500** (-4.0707)	0.4520 (0.9047))	-0.3046** (7.6219)	0.1156** (3.4198)
Wheat	0.0537 (0.7797)	-0.0101 (0.8688)	0.0316 (1.4827)	0.0201 (-1.2286)	-0.0047 (-0.2489)	-0.0006 (-0.0319)	-0.0045 (-0.7899)	-0.0014 (-0.2650)	-0.0304* (1.9969)	0.0012 (0.0819)	-0.0056 (-0.5798)
Pulses	0.2929** (4.2937)	-0.0387** (-3.7534)	0.0201 (-1.2286)	0.2056** (6.6629)	-0.0693* (-2.7873)	-0.0440 (-1.8198)	-0.0141** (-3.3288)	-0.0124** (-2.7530)	-0.0472 (-3.0012)	-0.0677** (-4.5905)	0.0590** (7.1661)
Oils	-1.1449** (6.5657)	0.0739** (2.6713)	-0.0047 (-0.2489)	-0.0693** (-2.7873)	0.0501 (0.9988)	0.0089 (0.2281)	-0.0034 (-0.3605)	-0.0278* (-2.2463)	-0.0277 (0.8612)	-0.2474** (-6.4290)	0.1361** (5.7608)
Sugars	0.1510* (2.1315)	-0.0141 (-1.2204)	-0.0006 (-0.0319)	-0.0440 (-1.8198)	0.0089 (0.2281)	0.0567* (1.9019)	0.0087 (1.4285)	-0.0035 (-0.5962)	-0.5225 (1.1389)	-0.2205 (-1.6675)	0.0036* (2.3348)
Fruits	-0.0316 (-0.6437)	-0.0053 (-0.7031)	-0.0045 (-0.7899)	-0.0141** (3.3288)	-0.0034 (-0.3605)	0.0087 (1.4285)	0.0306 (7.0455)	-0.0068 (-1.5871)	-0.0052 (0.8683)	0.0184 (1.6886)	-0.0052 (-0.6053)
Vegetables	0.3210* (2.3317)	-0.500** (-4.0707)	-0.0014 (-0.2650)	-0.0124** (-2.7530)	-0.0278* (-2.2463)	-0.0035 (-0.5962)	-0.0068 (-1.5871)	0.1044 (10.4310)	-0.0025 (0.0258)	-0.0095 (-0.2765)	-0.0532* (-2.3800)
Milk	-1.4173** (3.2876)	0.4520 (0.9047)	-0.0304* (1.9969)	-0.0472 (-3.0012)	-0.0277 (0.8612)	-0.5225 (1.1389)	-0.0052 (0.8683)	-0.0025 (0.0258)	-0.0026** (2.8729)	0.8301 (1.8926)	-0.2503 (-1.2204)

* Significant at 5 per cent level ** Significant at 1 per cent level

Table 58. Matrix of estimated elasticities of price, expenditure and household size for different food items of the selected sample households in Nagapattinam district under –normal condition

Items	Rice	Wheat	Pulses	Oils	Sugars	Fruits	Vegetables	Milk	Income elasticity	Household size
Rice	-1.2424	0.0144	-0.2306	-0.0480	-0.0641	-0.0462	-0.3099	-3.9804	0.9533	1.3874
Wheat	0.6870	-1.2162	-1.4210	-0.3541	-0.0455	-0.3195	-0.1170	-1.4328	-1.0788	0.4757
Pulses	-0.1355	-0.1699	-0.8928	-0.4661	-0.3804	-0.1076	-0.0165	-0.7831	0.3994	-1.1245
Oils	0.6422	-0.0049	-0.1669	-0.5509	0.0582	0.0153	-6.0442	0.0326	0.0045	1.5432
Sugars	-0.2868	-0.0137	-1.8919	4.6595	-1.5875	0.4320	-0.0020	-0.4926	-0.0173	1.1825
Fruits	-0.3981	-0.1631	-0.5522	0.2734	0.2825	-0.0268	-0.3314	-3.0387	1.6289	-0.8062
Vegetables	-0.2976	-0.0086	-0.0727	-0.1622	-0.0214	-0.0417	-0.3251	-2.1998	0.9388	-0.2779
Milk	-2.2954	-0.5883	-1.9631	3.2633	-1.5437	0.4117	-1.8525	-1.0042	0.4694	-9.2658

Table 59. Estimated parameters of AIDS model for Nagapattinam district– drought period

Items	Constant	Rice	Wheat	Pulses	Oils	Sugars	Fruits	Vegetables	Milk	Real per capita expenditure	Household size
Rice	0.2165* (2.1138)	0.08219* (1.9385)	0.0434** (2.7057)	-0.0434** (-3.8968)	-0.0240 (-0.8200)	-0.0039 (-0.6388)	0.0003 (0.0487)	-0.0463** (-2.6847)	-0.0082 (-0.9605)	-0.1594** (3.2845)	0.0738** (2.5008)
Wheat	0.0502 (-0.7737)	0.0434** (2.7057)	0.0015 (0.1082)	-0.0142 (-1.7046)	-0.0160 (-0.8084)	0.0003 (0.0329)	-0.0107* (-2.1967)	0.0088 (1.5291)	-0.0131 (1.0170)	-0.0270* (1.9196)	-0.0169* (-1.9361)
Pulses	0.3196** (6.1800)	-0.0434** (-3.8968)	-0.0142 (-1.7046)	0.1681** (18.209)	-0.0396** (-3.3699)	-0.0147** (-2.2946)	-0.0045 (-1.2358)	-0.0175** (-3.5592)	-0.0342 (1.7021)	0.9246** (9.1355)	0.0861** (13.634)
Oils	-0.0577 (0.4507)	-0.0240 (-0.8200)	-0.0160 (-0.8084)	-0.0396** (-3.3699)	0.1747** (3.9479)	0.0097 (0.2738)	-0.0040 (-0.2101)	-0.0558** (-3.6000)	-0.0450 (-0.8047)	0.03593 (1.2720)	-0.0677 (1.4603)
Sugars	-0.0661 (1.6167)	-0.0039 (-0.6388)	0.0003 (0.0329)	-0.0147** (-2.2946)	0.0097 (0.2738)	0.0215 (1.6452)	0.0003 (0.1432)	-0.0010 (-0.3415)	-0.0122 (-1.0239)	0.0084 (1.3352)	0.0020 (0.4920)
Fruits	0.0721 (1.7645)	0.0003 (0.0487)	-0.0107* (-2.1967)	-0.0045 (-1.2358)	-0.0040 (-0.2101)	0.0003 (0.1432)	0.0214** (5.5154)	-0.0005 (-0.1334)	-0.0023 (1.0740)	0.0061 (0.7016)	0.0091 (-1.6600)
Vegetables	0.0821** (3.5016)	-0.0463** (-2.6847)	0.0088 (1.5291)	-0.0175** (-3.5592)	-0.0558** (-3.6000)	-0.0010 (-0.3415)	-0.0005 (-0.1334)	0.1293** (9.2997)	-0.0170** (-2.6033	0.0293 (0.8623)	-0.0607** (-3.2184)
Milk	0.3833 (-0.2675)	-0.0082 (-0.9605)	-0.0131 (1.0170)	-0.0342 (1.7021)	-0.0450 (-0.8047)	-0.0122 (-1.0239)	-0.0023 (1.0740)	-0.0170** (-2.6033)	0.0169** (-3.8527)	-0.8179 (2.0709)	-0.0257** (3.5789)

*** Significant at 5 per cent level** **** Significant at 1 per cent level**

Table 60. Matrix of estimated elasticities of price, expenditure and household size for different food items of the selected sample households in Nagapattinam district under – drought condition

Items	Rice	Wheat	Pulses	Oils	Sugars	Fruits	Vegetables	Milk	Income elasticity	Household size
Rice	-0.9238	0.1169	-0.1824	-0.1810	-0.0183	-0.0084	-0.2035	2.8577	0.4570	0.5655
Wheat	2.0616	-0.9329	-1.0729	-1.3723	-0.0020	-0.6833	0.2834	-4.3555	2.6370	-2.6648
Pulses	-0.0887	-0.1008	-0.4220	-0.1340	-0.1050	-0.0205	-0.0258	-0.3219	2.2689	-1.4123
Oils	-0.0469	-0.0628	-0.1430	-0.2516	0.0421	-0.0053	-0.2050	-1.5263	1.8534	-0.4227
Sugars	-0.0633	0.0338	-0.8806	0.7644	0.3972	0.0350	0.0194	-2.1494	1.4554	-0.6751
Fruits	0.1200	-0.5082	-0.1799	-0.0266	0.0221	0.0325	0.0213	-0.2252	1.7063	-0.1432
Vegetables	-0.2334	0.0603	-0.0895	-0.3143	-0.0035	0.0007	-0.1347	-1.5036	1.8104	-0.2028
Milk	3.8656	0.0043	0.9648	2.1694	0.0067	0.2052	1.5595	-0.9946	0.8031	1.8733

Table 61. Estimated parameters of AIDS model for Karaikal region - normal period

Items	Constant	Rice	Wheat	Pulses	Oils	Sugar	Fruits	Vegetables	Milk	Real per capita expenditure	Household size
Rice	0.7941** (2.9809)	0.2222** (3.3186)	0.0414 (1.0934)	-0.0282 (-0.9175)	-0.1226* (-2.3452)	0.0045 (0.2575)	-0.0701 (-1.8435)	0.0389 (-1.6367)	-0.0861 (-0.5411)	-0.3405** (6.6987)	0.1201** (2.7379)
Wheat	-0.2795* (-1.9624)	0.0414 (1.0934)	-0.0515 (-1.1217)	-0.0613* (-2.0339)	-0.0735 (1.0332)	-0.3380 (1.2650)	0.0071 (0.3230)	-0.0355 (-3.2362)	0.5114 (-0.7586)	-0.0309 (1.1781)	0.0365 (1.7395)
Pulses	-0.2940** (3.0193)	-0.0282 (-0.9175)	-0.0613* (-2.0339)	0.2571** (3.7337)	-0.1479** (-2.6705)	0.0294 (0.5667)	-0.0213 (-1.6063)	-0.0176** (-2.6691)	-0.0101* (-2.1685)	-0.0583** (-3.6789)	0.0729** (4.6411)
Oils	1.0487** (4.6863)	-0.1226* (-2.3452)	-0.0735 (1.0332)	-0.1479** (-2.6705)	0.0881 (0.6248)	0.1314 (1.4819)	0.0211 (0.7157)	0.0182 (0.8342)	0.0852 (0.6721)	0.1750** (-4.3954)	-0.0297 (-1.1281)
Sugar	-0.0578 (-0.6684)	0.0045 (0.2575)	-0.3380 (1.2650)	0.0294 (0.5667)	0.1314 (1.4819)	-0.1379* (-2.1270)	-0.0074 (-0.7060)	-0.6120 (-1.8121)	0.9300 (-0.08047)	0.0133 (-1.1185)	-0.0112 (1.1731)
Fruits	-0.11483 (0.7950)	-0.0701 (-1.8435)	0.0071 (0.3230)	-0.0213 (-1.6063)	0.0211 (0.7157)	-0.0074 (-0.7060)	0.0490 (1.3530)	0.0056 (0.3514)	0.0160** (-4.8488)	0.0335 (-0.9365)	-0.0096 (-0.3052)
Vegetables	-0.2617 (1.4975)	0.0389 (-1.6367)	-0.0355 (-3.2362)	-0.01765** (-2.6691)	0.0182 (0.8342)	-0.6120 (-1.8121)	0.0056 (0.3514)	0.1005** (4.9747)	0.5019 (-0.9701)	-0.0413 (-1.1479)	-0.0403 (1.5563)
Milk	0.1650** (-4.1940)	-0.0861 (-0.5411)	0.5114 (-0.7586)	-0.0101* (-2.1685)	0.0852 (0.6721)	0.9300 (-0.0804)	0.0160** (-4.8488)	0.5019 (-0.9701)	-1.9483* (-2.1685)	0.2492** (-2.8596)	-0.1387** (3.8758)

* Significant at 5 per cent level ** Significant at 1 per cent level

Table 62. Matrix of estimated elasticities of price, expenditure and household size for different food items of the selected sample households in Karaikal region under – normal condition

Items	Rice	Wheat	Pulses	Oils	Sugars	Fruits	Vegetables	Milk	Income elasticity	Household size elasticity
Rice	-0.7419	0.0920	-0.1778	-0.5420	-0.0044	-0.2154	-0.2423	-3.7493	-0.9173	1.2408
Wheat	1.4023	-3.4516	-3.0348	3.1094	1.5594	0.2941	-1.8827	-4.4557	2.4517	-0.2589
Pulses	-0.0598	-0.5424	-1.3796	-1.2141	0.2758	-0.1771	-0.0804	-0.8918	0.4733	-1.1855
Oils	-0.2500	0.3348	-0.5572	-0.4428	0.5836	0.1133	0.1926	-2.2666	0.2412	0.6296
Sugars	0.5218	1.8721	1.6993	7.3802	-8.5546	-0.3889	-0.5503	-4.7123	0.2612	1.3496
Fruits	-2.0012	0.2735	-0.6096	1.0007	-0.2380	-0.6279	0.3706	-0.4126	-0.1643	-0.8645
Vegetables	-0.1573	-0.2312	-0.0872	-5.1854	-0.0752	0.0456	-0.2881	-0.9617	0.7243	0.5447
Milk	2.5922	1.3483	-0.5469	-0.4022	2.8385	0.1281	1.7426	-1.1354	0.2762	1.9541

Table 63. Estimated parameters of AIDS model for Karaikal region – drought period

Items	Constant	Rice	Wheat	Pulses	Oils	Sugars	Fruits	Vegetables	Milk	Income	Household size
Rice	0.7275* (2.2368)	0.1443* (2.4020)	0.0334 (0.8881)	-0.0584* (-2.3613)	-0.0278 (-0.6424)	-0.0085 (-0.8934)	-0.0068 (-0.3718)	-0.0577* (-1.9822)	-0.0185 (-0.1978)	-0.3041** (4.6149)	0.1184** (2.6244)
Wheat	0.0256 (0.1660)	0.0334 (0.8881)	-0.0411 (-0.7524)	0.0054 (0.1584)	-0.0217 (-0.4333)	-0.0032 (-0.2515)	-0.0095 (-0.6928)	0.00411 (0.2320)	0.03259* (1.9862)	-0.0092 (-0.3335)	0.4043 (1.5349)
Pulses	0.4172** (3.7832)	-0.0584* (-2.3613)	0.0054 (0.1584)	0.1903** (3.4039)	-0.0726 (-1.0007)	-0.0063 (-0.2830)	0.0024 (0.3578)	-0.0121 (-0.8311)	0.0487 (-0.8234)	0.0880** (6.0714)	0.0381* (2.3993)
Oils	0.4555* (2.1601)	-0.0278 (-0.6424)	-0.0217 (-0.4333)	-0.0726 (-1.0007)	-0.2298 (1.4923)	-0.0355 (-0.3347)	-0.0021 (0.1470)	-0.0776** (-2.5948)	0.0467 (-1.0062)	0.1495** (4.6417)	-0.1077 (3.5207)
Sugars	-0.2141 (0.2778)	-0.0085 (-0.8934)	-0.0032 (-0.2515)	-0.0063 (-0.2830)	-0.0355 (-0.3347)	-0.0078 (-0.2754)	-0.0028 (-0.9530)	-0.0009 (-0.1192)	0.0650 (0.4571)	0.0094 (1.6409)	0.0010 (0.1604)
Fruits	-0.0504 (-0.3631)	-0.0068 (-0.3718)	-0.0095 (-0.6928)	0.0024 (0.3578)	-0.0021 (0.1470)	-0.0028 (-0.9530)	-0.0348** (3.0468)	-0.0151 (-1.1366)	0.6451* (-1.9015)	0.0177 (0.6409)	0.0045 (0.2106)
Vegetables	-0.4474* (2.2663)	-0.0577* (-1.9822)	0.00411 (0.2320)	-0.0121 (-0.8311)	-0.0776** (-2.5948)	-0.0009 (-0.1192)	-0.0151 (-1.1366)	0.1638** (6.8941)	-0.0045 (-0.0547)	0.0280 (0.7205)	-0.0554* (-1.9627)
Milk	0.0861 (2.3478)	-0.0185 (0.1978)	0.03259* (1.9862)	0.0487 (-0.8234)	0.0467 (-1.0062)	0.0650 (0.4571)	0.6451* (-1.9015)	-0.0045 (-0.0547)	0.02294** (4.8728)	0.0207** (2.7503)	-0.4032 (-0.2515)

* Significant at 5 per cent level ** Significant at 1 per cent level

Table 64. Matrix of estimated elasticities of price, expenditure and household size for different food items of the selected sample households in Karaikal region – drought condition

Items	Rice	Wheat	Pulses	Oils	Sugars	Fruits	Vegetables	Milk	Income elasticity	Household size
Rice	-0.9154	0.0703	-0.2508	-0.2540	-0.0350	-0.0431	-0.2833	-3.5304	0.8187	1.1376
Wheat	1.5250	-2.6911	0.2700	-0.8165	-0.1306	-0.3844	0.2298	-2.6158	0.6178	-2.0495
Pulses	-0.2254	0.0666	-0.7557	-0.4677	-0.0445	0.0448	0.0140	-0.08511	1.2285	-1.1056
Oils	0.1266	-0.0830	-0.2541	-0.2004	-0.1525	0.0302	-0.2481	-0.6968	1.3163	1.1762
Sugars	-0.3399	-0.2080	-0.3590	-2.2700	-1.5253	-0.1714	0.0940	-5.1359	-0.3562	0.7136
Fruits	-0.4461	-0.3318	0.0141	-0.0590	-0.1019	-0.1383	-0.5924	-2.9685	1.8895	-0.4392
Vegetables	-0.3036	0.0307	-0.0573	-0.4580	0.0020	-0.0913	0.0777	-2.2129	1.8205	-0.1761
Milk	-0.3897	0.3723	-0.5962	0.6060	0.8064	0.0063	0.1017	-0.9978	0.4678	0.6957

* Significant at 5 per cent level ** Significant at 1 per cent level

Table 67. Migration during drought in the study area

Incidence/ reasons for migration	Nagapattinam		Karaikal	
	Small farmers	**Large farmers**	**Small farmers**	**Large farmers**
1. Incidence of migration				
a) Households migration number	16 (14.44)	8 (8.89)	9 **(30)**	6 **(20)**
b) No. of persons migrated	20	12	15	11
c) Average number of mandays employed per person	105	220	95	195
2. Reasons for migration				
a) Employment	15 **(16.67)**	8 **(8.89)**	8 **(26.67)**	5 **(16.67)**
b) Fodder	-	-	-	-
c) Dependent member	5 **(5.56)**	4 **(4.44)**	3 **(3.33)**	2 **(2.22)**

Figures in parentheses represent percentage to total respondents

Table 69. Credit borrowings by the sample respondents during drought year (Rs)

Sl.No	Region / Category	Source and amount borrowed							Total
		Large farmers	Private jewel loan	Relatives	Friends	Moneylenders	Traders	Institutions	
1	**Nagapattinam**								
	Small	1524.0 **(45.73)**	352.75 **(10.59**)	528.35 **(15.85)**	-	927.32 **(27.83)**	-	-	3332.42 **(100.0)**
	Large	-	1327.25 **(31.30)**	-	-	-	1925.38 **(45.42)**	987.25 **(23.28)**	4239.88 **(100.0)**
2	**Karaikal**								
	Small	1237.32 **(48.30)**	287.43 **(11.22)**	152.67 **(5.96)**	-	884.32 **(34.52)**	-	-	2561.74 **(100.0)**
	Large	-	987.38 **(32.27)**	115.38 **(3.78)**	-	-	1128.37 **(36.88)**	828.35 **(27.07)**	3059.48 **(100.0)**

Figures in the parentheses represent percentage to row mean