CHAPTER IV RESULTS AND DISCUSSION

The results of the study on "An analysis of pattern, growth and determinants of Fertilizer use in Tamil Nadu" is presented under the following heads;

I. Consumption of fertilizer in Tamil Nadu and Coimbatore district (Secondary data).
II. Fertilizer purchase and usage behavior of farmers in Tamil Nadu (Primary data).

I. Consumption of fertilizers in Tamil Nadu and Coimbatore district
   1. State level analysis on consumption of fertilizers
   2. State- wise consumption of fertilizer per unit of gross cropped area
   3. Pattern of fertilizer consumption in Tamil Nadu
   4. District wise consumption of fertilizer per unit of gross cropped area
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   6. District level analysis of fertilizer consumption
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II. Fertilizer purchase and usage behavior of farmers in Tamil Nadu
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I. CONSUMPTION OF FERTILIZER IN TAMIL NADU AND COIMBATORE DISTRICT

Chemical fertilizers have been an important element of Indian agriculture. However, there have been wide variations in the use of fertilizers across states and district as also over time it proved that there are differences in the pattern, growth and determinants of fertilizer use among states and districts in the country.

1. STATE LEVEL ANALYSIS ON CONSUMPTION OF FERTILIZERS

Because of the importance of agriculture in the economy, emphasis is placed on increasing production and productivity of agricultural sector in general and food grains in particular in the state of Tamil Nadu. Inputs like fertilizers, HYV seeds, irrigation and pesticides are being increasingly applied in modern times to improve yields. Among these, application of fertilizers occupies an important place. It has been proved in many research studies that on controlled plots and farmer's field fertilizer application is the most potent means of getting higher agricultural production in a short time. However, there is wide variation in the consumption of fertilizer by each state as shown in Table 1.

State- wise fertilizer consumption indicated that, Uttar Pradesh had the rare distinction of crossing the three million tonnes consumption mark during 2009-10, recording a rate of growth 15.34 percent over 1980-81. The reason for increase in fertilizer consumption were, better availability of credit, subsidy on P2O5 and K2O, transport subsidy for moving fertilizer into interior markets, priority of power to agricultural sector, adequate availability of water and quality seed of high- yielding varieties. The total fertilizer consumption in the state of Tamil Nadu increased from 491.30 thousand tonnes in 1980 - 81 to 1196.85 thousand tonnes in 2009-10. The percentage rate of growth of fertilizer consumption in Tamil Nadu, during 2009- 10 over 1980-81 reveled a positive trend (3.48 percent). The factors responsible for positive trend in Tamil Nadu was massive extension efforts to stimulate fertilizer consumption through media, subsidy on P2O5 and K2O, adequate distribution of quality seed of high - yielding varieties, increased coverage of HYV seeds, better of credit availability and adequate fertilizer supply.
2. STATE-WISE CONSUMPTION OF FERTILIZER PER UNIT OF GROSS CROPPED AREA

Pattern of fertilizer consumption can best be reflected by examining in proportion of fertilizer consumed in different states. State-wise rate of consumption of fertilizers in term of nutrients in kg per hectare of gross cropped area for 2009-10 is given in Table 2.

It is evident from table 2, that the state of puducherry has the highest consumption of fertilizer per unit of gross cropped area i.e. 878.9 Kg per hectare. The share of fertilizer consumption per unit of gross cropped area was maximum accounting for 62.97, 16.37 and 20.64 percent in respect of N, P and K respectively during the year 2009-10. Punjab stands in the second place with 237.1 Kg per hectare, followed by Andhra Pradesh with 225.6 Kg per hectare. Tamil Nadu held the fifth place in fertilizer consumption per unit of gross cropped area with 205.8 Kg per hectare in 2009-2010. The share of NPK to total fertilizer consumption was 50.85, 22.03 and 27.12 percent respectively. The reasons for increase in fertilizer consumption in these areas were better availability of credit, subsidies, adequacy of water, number of sales points etc. In major paddy growing states like Andhra Pradesh, Karnataka, Tamil Nadu and West Bengal, the level of fertilizer use per unit of gross cropped area has been considerably high. Similar result were reported by Santra and Sarker (1989) and Bhatia (1983).

3. PATTERN OF FERTILIZER CONSUMPTION IN TAMIL NADU

Over the last three decades, the overall production of food grains in Tamil Nadu has increased. This increase was due to the application of new input technology. In the new package of inputs, the role of chemical fertilizer assumes greater importance. While observing the growth of fertilizer use in India as well as in Tamil Nadu, a significant growth could be observed. In Tamil Nadu, growth of total NPK consumption has recorded 52 fold increase from 1951-52 to 1984-85. In terms of intensity of fertilizer use (kg / ha) among states, Tamil Nadu ranked second, according to Mohanam (1990). The fertilizer consumption in Tamil Nadu in terms of N, P and K is presented in Table 3.
The annual growth rate of consumption of Nitrogen fertilizer reached maximum growth of 25.28 percent during 1983-84. It came to the lowest level of a negative percentage of 16.16 during 2002-03. In the year, 2009-10 it reached -3.40 percent. The annual growth rate for P was at a high level of 33.56 percent during 1997-98. It came to the lowest level of a negative percentage of 21.11 during 1995-96. In the year 2009-10, it reached 3.52 percent. However, there were fluctuations in the consumption of potash fertilizer. But nitrogen still continues to be the major nutrient consumed in the state. The annual growth rate for K reached the maximum level of 46.59 percent during 2004-05. It came to the lowest level of a negative percentage of 28.06 during 1992-93 and in the year 2009-10, it reached -10.46 percent.

The annual growth rate of consumption of fertilizer in Tamil Nadu has shown a fluctuating trend. The annual growth rate for N, P and K was the highest during 1983-84 showing a percentage of 24.41. The rise in the fertilizer consumption was due to improvement of irrigation and extension of new technology etc. It reached the negative level of 20.68 percent during 2002-03. This slowdown in fertilizer use was one of the most significant factors in the slowdown in agriculture growth from the mid 1992 to 2004-05 (Chand et al, 2007). In the year 2009-10, it was at a level of -4.11 percent. This may due to lack of irrigation facilities and rainfall deviations. The exponential growth rate of consumption of K was the highest with 3.1 percent followed by P with 2.9 percent and N with 2.1 percent. The overall growth for N P K consumption in Tamil Nadu was 2.5 percent. The coefficient of a variation was the highest for K showing 31.71 percent followed by P having 28.32 percent and 14.12 percent for N. The consumption of nitrogen in Tamil Nadu had shown great stability as against P and K. The total NPK consumption in Tamil Nadu recorded variation of 24.15 percent.
4. DISTRICT-WISE CONSUMPTION OF FERTILIZER PER UNIT OF GROSS CROPPED AREA

One of the important features of consumption of fertilizer in Tamil Nadu is the wide variation in fertilizer consumption levels among the different districts of the state. The district-wise consumption of NPK fertilizer per unit of gross cropped area in Tamil Nadu for the period of 2009-2010 is presented in Table 4.

Total fertilizer consumption per unit of gross cropped area was maximum in Tiruchirapalli at 488.8, with 225.8, 110.2 and 152.9 kg per hectare of N, P, K respectively accounting for 46.18, 22.53 and 31.27 percent during the year 2009-10. The reason for an increase in fertilizer consumption were intensive fertilizer promotion campaign, greater emphasis on television programme, better fertilizer supply and increased area under HYV crops etc. The study also coincides with the findings of Rao (1982). Coimbatore district ranked 15th place in the consumption of NPK (198.9 kg/ha) accounting for 42.73, 21.11 and 36.15 percent of N, P and K respectively. The common trend in fertilizer consumption in Tamil Nadu is that use of nitrogenous fertilizer has increased at a relatively faster rate than phosphatic and potassic fertilizer. This has increased the imbalance in the use of plant nutrients, which in the long run is believed to have an adverse impact on soil fertility and crop productivity. Research conducted by ICAR under the 'All India Coordinated Research project on long-term fertilizer experiments' show that continuous use of N alone produces a decline in yield and has a deleterious effect on long-term fertility and sustainability (Anand and Wanjari 2000).

5. DETERMINANTS OF FACTORS AFFECTING FERTILIZER USE IN TAMIL NADU

In this section, we examine the factors influencing fertilizer use in Tamil Nadu. For this purpose variables viz: net irrigated area, rainfall, price of fertilizer, area of HYVP crops and gross cropped area, were considered. Multiple linear regression model was used to study simultaneous impact of net irrigated area, rainfall, price of fertilizer, area of HYVP crops and gross cropped area.
The $R^2$ value of 0.90 indicates that the fit was good. That is, 90 percent of the variation in fertilizer use was caused by five explanatory variables like net irrigated area, annual rain fall, price of fertilizer, area of HYVP crops and gross cropped area. F value emerged statistically significant at one percent level, signifying the overall goodness of fit of the regression model. The net irrigated area was the most dominant factor in explaining the variations in fertilizer consumption. It was statistically significant at one percent level and positively related to fertilizer consumption. It implies that one unit increase in this variable is capable of increasing fertilizer consumption by 0.074 units respectively. Gross cropped area was negatively and significantly related to the quantity of fertilizer used. This indicates a unit increase in the gross cropped area reduced the quantity of fertilizer used by 0.028 units respectively. This may be due to the increase in demand for organic products which will make use of organic fertilizer. However, the relationship between fertilizer consumption with annual rain fall, price of fertilizer and area of HYVP crops was relatively weak (non-significant). Similar result was recorded by Sing and Jose (1999).

### 6. DISTRICT LEVEL ANALYSIS OF FERTILIZER CONSUMPTION

1) **District level analysis of fertilizer consumption in Tamil Nadu**

District level analysis of consumption of fertilizers (N+P2O5+K2O) in Tamil Nadu for the three decades (1980-81 and 2009-2010), are presented in Annexure -4

Generally, fertilizer consumption depends upon the rainfall, gross cropped area and socio-economic characteristics of the farmers. Annexure-4 reveals that the highest annual growth rate is found in Ramanathapuram and Nilgiris districts (718.18 percent) in 2002-03 and 2003-04. It might be due to the fast adoption of improved technology and good weather condition. It came to the lowest level of a negative percentage of 86.59 during 2001-02 in Nilgiris. From the table it could be noticed that the growth rate was constant for Coimbatore district during the year 1990-91.

Nilgiris district had the highest exponential growth rate in fertilizer consumption (7.5 percent) and also the coefficient of variation (122.27 percent),
implying large disparities. It is followed by North Arcot, where the growth rate was 3.1 percent and the co-efficient of variation was 101.23 percent for Kanyakumari. Negative growth rate was found in Pudhukottai district (4.8 percent) and lowest coefficient of variation was found in Coimbatore district (18.1 percent), which implies lower variance. Higher variance denotes large disparities among different years (inter-temporal) and lower variance shows small disparities in different years for a single district. The study was in line with the findings of Singh (1998) and Leela (1983). From annexure - 4, it is interesting to note that, for majority of the districts exponential growth rate was statistically significant.

2. District - wise share of fertilizer consumption

Consumption of fertilizer by various states in Tamil Nadu is analyzed and presented in Table 6.

The district of Tiruchirapalli has the highest share in the total NPK consumption of fertilizer in Tamil Nadu as is revealed in the above table. The share was 7.61 percent, followed by Erode with 7.44 percent. In other districts it was of the order of Villupuram (6.39 percent), Salem (6.31 percent) and Coimbatore district (6.28 percent). Thus, Coimbatore occupied the fifth place in the relative consumption of NPK in Tamil Nadu. Villupuram has the highest share in the gross cropped area of the state with 6.60 percent, while Coimbatore occupied the 13th place with 3.39 percent.

However, in terms of per hectare consumption (GCA) of total (NPK) fertilizer, Tiruchirapalli occupied highest place with 488.8 kg, followed by Madurai with 396.3 Kg and Erode with 387.5 kg. Coimbatore district occupied 15th place with 198.9 Kg. per hectare which was lower than the Tamil Nadu states average of 208.3 Kg. per hectare in 2009-10.
7. CONSUMPTION PATTERN OF FERTILIZER IN COIMBATORE DISTRICT

The Coimbatore District has the fifth place in total fertilizer consumption in 2009-2010 as compared to other districts in Tamil Nadu. The pattern of consumption of fertilizer in Coimbatore district for the study period (1980-81 to 2009-2010) is depicted in table 7.

The annual growth rate for consumption of N fertilizer reached its maximum level of 38.09 percent during 1984-85. It came to the lowest level of a negative percentage of 23.33 during 2002-03. The annual growth rate for P was its maximum level of 85.71 percent during 1997-98. It came to the lowest level of a negative percentage of 20 during 2002-03. In the year 2009-10, it reached 3.52 percent. However, there were fluctuations in the consumption of potash fertilizer. But nitrogen still constituted the major nutrient consumed in the district. The annual growth rate for K reached its maximum level of 66.66 percent during 1988-89. It came to the lowest level of a negative percentage of 28.06 during 1992-93 and in the year 2009-10, it reached 3.70 percent.

The annual growth rate for consumption of fertilizer (NPK) in Coimbatore district has shown a fluctuating trend. The highest average growth rate for N, P and K was witnessed in the year 1997-98, the value being 42.55 percent. The sharp rise in the fertilizer of consumption during the period was mainly due to the development of irrigation facilities, use of fertilizer, application of high yielding variety of seeds and extension of crop loan to the farmers. Lowest growth rate was found in the year 2006-07 with 1.67 percent. There was a deceleration observed in 14 years viz., 1981-82, 1982-83, 1985-86, 1986-87, 1991-92 to 1993-94, 1995-96, 1996-97 and 2000-01 to 2003-04 the value being lowest level of a negative percentage. The negative percentage of annual growth rate for the years showed that during the unfavorable weather and monsoon conditions, fertilizer consumption was affected in those areas which had not possessed assured irrigation facilities because the farmers minimize their losses by reducing the expense on fertilizers. The exponential growth rate of consumption of K was the highest with 0.28 percent followed by P with 0.06
percent and N with 0.01 percent. However, there was no progress in the consumption of nitrogen fertilizer. The overall growth for N P K consumption in Coimbatore district was 1.0 percent. The coefficient of a variation was the highest for K showing 31.88 percent followed by P having 22.64 percent and 14.19 percent for N. The consumption of nitrogen in Coimbatore district had shown great stability as against P and K. The total NPK consumption in Coimbatore district recorded variation of 18.12 percent.

8. GROWTH, INSTABILITY AND FUTURE PREDICTION ON FERTILIZER CONSUMPTION

1) Trends in fertilizer consumption

Trends in fertilizer consumption in India, Tamil Nadu and Coimbatore district were estimated by using Exponential trend analysis. A trend shows regular on irregular movement of fertilizer use over a period of time.

The estimated Exponential Trend Equation of Fertilizer Consumption in India is given below.

\[ Y = 6349.52 + 1.0479X \]
\[ F \text{ value } (542.80)** R^2 = 0.95 \]

(** statistically significant at 1 percent level)

The estimated Exponential Trend Equation of Fertilizer Consumption in Tamil Nadu is given below.

\[ Y = 5.5064 + 1.0251X \]
\[ F \text{ value } (86.10)** R^2 = 0.76 \]

(** statistically significant at 1 percent level)

For Coimbatore district Exponential Trend equation is given below.

\[ Y = 0.4894 + 1.0095X \]
\[ F \text{ value } (7.58)** R^2 = 0.21 \]

(** statistically significant at 1 percent level)

Fertilizer consumption has shown an increasing trend during the study period. The regression coefficient had shown that, every year the quantity of fertilizer consumption increased by 1.0479 thousand tonnes in India, 1.0251 lakh metric tonnes in Tamil Nadu and 1.0095 lakh metric tonnes in Coimbatore district. The F value for the estimated equation for India, Tamil Nadu and Coimbatore district, indicate that the increase in fertilizer consumption was
statistically significant.

The trend value of fertilizer consumption in India, Tamil Nadu, and Coimbatore district were calculated using the estimated equation. The calculated trend values are given in the Table 8.

Sources: Values calculated based on the data in Annexure -1, and table 3 and 7. The trend line has been generated and it is given in the figures - 6, 7 and 8. When the actual values and trend values of fertilizer consumption in India, Tamil Nadu and Coimbatore district are graphed, it can be seen that the actual value had moved above and below the trend line.

The relative cyclical residual indicates how the actual values are either short off or in excess of the estimated values.

In India during the 30 years period the actual quantity of fertilizer consumption was in excess of the estimated fertilizer consumption for 16 years (1983-84 to, 1985-86, 1988-89,1989-90,1991-92 to 1999-2000, 2008-2009 and 2009-10) and for the remaining 14 years it was less than the estimated value. In Tamil Nadu, the actual quantity of fertilizer consumption was in excess of the estimated fertilizer consumption during 18 years (1984-85 to 1985-86,1994-95, 1997-98 to 2000-01, 2006-2007, 2008-2009 and 2009-10) and for the other twelve years it was less than the estimated value. In Coimbatore district, the actual quantity of fertilizer consumption was in excess of the estimated fertilizer consumption during 15 years of the study period (1980-81, 1984-85, 1987-88 to 1991-92,1997-98 to 2001-02, 2007-08 , 2008-09 and 2009-10) and for the other years it was less than the estimated value.
2) Kinked Exponential Model for Growth Rate Estimation

To examine the growth rate of fertilizer consumption (kg/ha) in India, Tamil Nadu and Coimbatore district, decade -wise estimation was done by fitting kinked exponential function. Kinked exponential model for growth rate are presented in the Table 9.

The fertilizer consumption in India had recorded an appreciable growth rate in sub-period I (7.40 percent) and least growth rate in sub-period II (2.95 percent), while the growth of fertilizer consumption in Tamil Nadu showed a highest growth in sub-period I (6.77 percent) and least growth rate in sub-period II (1.46 percent). The fertilizer consumption in Coimbatore showed a highest growth rate in sub-period III (1.08 percent) and least growth rate in sub-period II (0.23 percent). Growth of fertilizer consumption in India and Tamil Nadu was statistically significant for all three sub-periods. Growth rate of fertilizer consumption was not significant for sub-period II and III and significant for sub-period I for Coimbatore district.

3) Instability Indices for Fertilizer Consumption

The performance of fertilizer consumption of a state/district during any given time period is measured not only from the point of view of increase in fertilizer consumption but also on the extent of fluctuations in fertilizer consumption. Hence, an attempt was made to study the degree of instability in fertilizer consumption in India, Tamil Nadu and Coimbatore district, for the reference period by estimating the instability index and the results are shown in Table 10.

The Instability Indices calculated for fertilizer consumption in India, Tamil Nadu and Coimbatore districts has showed significant fluctuation. From the table, it is evident that India showed a lower variation (39.19 percent) when compared to the variation in Tamil Nadu (43.22 percent) and Coimbatore district (42.32 percent).
4) Future prediction on fertilizer consumption

The table 11 shows the future prediction on fertilizer consumption for the period 2011-12 to 2020-21.

From the present study, it was expected that, due to the growth of the fertilizer consumption, the country would attain a better position in agricultural development. By the year 2020-21, the fertilizer consumption in India, Tamil Nadu, and Coimbatore district was expected to increase by 456.73 lakh metric tonnes, 15.2 lakh metric tonnes and 0.72 lakh metric tonnes respectively.

The increasing trend might be due to the transport subsidy for moving fertilizers into the interior markets, ready availability of high yielding varieties of seeds, availability of water, intensive fertilizer promotion campaign, availability of credit, and other government programs. According to Nutrient Based Subsidy (NBS) policy P&K fertilizers (2010) in the context of nation’s food security, the declining response of agricultural productivity to increased fertilizer usage in the country has been a matter of concern. To ensure balanced application of fertilizers, the government intended to move towards Nutrient Based Subsidy regime instead of the exiting product pricing regime. The policy is expected to promote balanced fertilization through new fortified products and lead to an increase in agricultural productivity and consequently better returns for farmers.

II. FERTILIZER PURCHASE AND USAGE BEHAVIOR OF FARMERS

To substantiate the results obtained from secondary data, more information with reference to fertilizer consumption was collected from the farming community. To collect precise information on the usage of fertilizers by the farmers, primary data were collected as a part of the study. The investigator made use of a questionnaire (Annexure-1) in order to collect details on socio-economic background and also on farming activities with special focus on fertilizer use.
1. **SOCIO- ECONOMIC PROFILE OF THE RESPONDENTS**

1) Socio- economic profile of the respondents

In the light of the ongoing structural changes and consequent changing contours of rural economy as a whole, the nature and pattern of farming also has been changing over time. In India, especially in rural areas, the social status and identification of an individual, starts from the household to which the individual belongs. This is mostly determined by the personal characteristics of the farmer's household and so it is necessary to discuss the individual characteristics of the households.

In this section, a brief account of socio - economic characteristics of the selected samples are presented. The details of the respondent in terms of sex, age, income, education, family size, etc., are discussed in table 12.

The total number of sample respondents is 300, among them 191 respondents are male and 109 respondents were female. The proportion of male respondents was higher than female respondents.

Age is an important variable affecting decision making ability. The age of the sample respondents revealed that majority of them come under age group of 35-45 years. These farmers are more experienced in agriculture operations. Remaining 22.7 percent of them belong to age group between 25-35 years, 18.3 percent are in the age group of 45-55 years and 19 percent of them are above 55 years.

The greater part of the sample respondents (66 per cent) were Hindus. Remaining respondents were Muslim (21.7 per cent) and 12.3 percent were Christians. The villages had many communities that co-exist in a harmonious way.

Community has been a peculiar feature of Indian society determining the status of its member on the basis of birth as also prescribing the corresponding roles. In India, community is split on different group like Forward, Backward, Most Backward, Scheduled Caste and Scheduled Tribes. Majority of the sample respondents (44.7 percent) belonged to backward castes. The next important group was most backward class with 18.7 percent. Remaining 17.7 percent of sample respondents belonged to other caste which was followed by scheduled caste and scheduled tribes.
Marital status of the respondents revealed that, 73.7 percent of the respondents were married and about 17.7 percent were unmarried. Remaining 4 percent are divorces and 4.7 percent of them are widowed.

In India, family structure is divided into nuclear family and joint family. A nuclear family includes husband, wife, and children who are not of age of marriage and is referred to as a conjugal family. Joint family includes husband, wife, children, and their parents living under a single roof and is referred to as complex family. The survey revealed that 66.3 percent of them belonged to nuclear family and 33.7 of them were under joint family system. The growing urbanization might have influenced the people to prefer nuclear families that could satisfy the basic needs of the family.

The size of the family is an important factor to determine the requirements of family. The survey revealed that around 40 percent of the house hold had five members in family, while 32 percent had more than five members.

According to Kalirajan and Shand (1985), the level of formal education of farmers was not a significant factor, but that farmer's non-formal education (understanding the technology), which was independent of formal education, was a significant influence”.

In the selected area 40.7 percent of the respondent had secondary education; 35.3 percent had primary education. About 12.3 percent had higher secondary education and 6.3 percent of them had done a degree course. Only 5.0 percent were illiterate. It is quite strange to see a very low proportion as illiterates in a rural area.

Farmers are classified into small, medium and large farmers on the basis of their land holdings. Farmers having less than 5 acres of land are considered as small farmers, farmers having five to ten acres of land are medium farmers and framers having more than 10 acres of land come under large farmer's category. In this study greater part of the sample respondents (60.7 percent) were medium farmers, 25.3 percent of them were small farmers and only 14 percent of the respondents were large farmers.

Experience of the farmers is one of the deciding factors for the rational use of chemical fertilizers in cultivation. In this study, majority of the sample
respondents (41.7 percent) had 10-20 years of farming experience; 35 percent of
them have less than 10 years and only 23.3 percent of the respondents have more
than 20 years of farming experience.

Monthly income is the amount of money a person or an individual earns from
all sources, including employment and self-employment received as wage or salary
from organized or unorganized sector per month. Table 12 reveals that, 28.3
percent of sample respondents get an income below $10000. Some of the
respondents (39 percent) earn income between $10,000-20,000 and 32.7 percent
of respondents get an income above of $20,000 per month.

2) Sources of income of the household

Income is the most important indicator of assessing human development
index. The classification of people and even countries on a wider scale is made
on the basis of income. Income is drawn from various sources like wages, salary,
rent and livestock as is shown in the table 13.

The source of income varies for individuals and it is derived from different
sources. Income from livestock seems to be the major source for the first two
levels of income i.e. below $5000 and $5,000-10,000. Since they live in rural
areas most of them have plots of land and this enables them to find green
pastures for their cows and sheeps. They get lot of products from their livestock
which is sold out. The households do get income from other family members who
are working outside the purview of agriculture. Many children of these respondents
are working in companies, leths and are also doing business. Few women were
working in some sectors. So all the income are pooled together, and it is quite
interesting to observe that around 55.9 percent of the household do earn above
$10,000 per month. Majority (21.3 percent) of the respondents earned an income
($5, 000-10,000) from other sources like lending for interest and doing chit funds.
2. LAND HOLDINGS AND SOURCES OF IRRIGATION

1) Land holdings

Table 14 depicts different type of land owned by the farmers. There were 133 (73 percent) farmers who had a possession of 5-10 acres and 44 (57.9 percent) had less than 5 acres followed by 28 (66.7 percent) who owned more than 10 acres. Since these were irrigated it could be ploughed.

It is to be noted that, though many own irrigated and non-irrigated land, all of them do not cultivate. It was found that a large (127) number of farmers held irrigated land of 5-10 acres and only 15 farmers owned above 10 acres of land. But in the case of non-irrigated land majority of the (37.5 percent) respondents hold land above 10 acres and 20.6 percent of them had to make use of their non-irrigated land (5-10 acres) for the cultivation work.

In the study area majority (55.3 percent) of the sample respondents have lease in land (below 5 acres) for their farming. Only 13.1 percent of them had above 10 acres lease in land. In a similar way in the leased out land, 18 farmers (below 5 acres) lent their land for farming but only two farmers leased out their land (above 10 acres) for farming.

2) SOURCES OF IRRIGATION

Development of dependable and efficient source of irrigation is essential for enhanced use of fertilizer (Kayarkanni, 2000). Hence, improving the existing irrigation system is essential in order to encourage the increased use of modern input like fertilizers. Sources of irrigation of the respondent are given in Table 16.

Majority of the respondents (54 percent) used bore well as a major source of irrigation in Thondamuthur block; 20 percent make use of common well and 15.3 percent of them utilize tank. The other major source of irrigation is tube well. The quality of irrigation was consistent in influencing fertilizer use.
Nadu, majority of them (61.3 percent) were found to be using electric motor as a means of drawing water, 31.0 percent of them make use of diesel engine and 7.7 percent utilize other means of drawing water like oil and kerosene engine.

3. COST OF CULTIVATION

Cost studies provide information and knowledge essential for the formulation and evaluation of economic policies both at micro and macro levels. This average cost of cultivation includes all the expenses towards purchase of fertilizer, seed, and pesticide, labor cost, irrigation and ploughing etc., for all crops. These average cost of cultivation (per acre per annum) were incurred by sample respondents and it is given in Table 17.

Among the various expense, those spending above ₹10,000 for fertilizer is to the tune of 135 (37 percent). Only a few (8.1 percent) spend below ₹5,000. A major proportion (217 respondents) spends below ₹5,000 for seeds and 30 respondents spend above ₹10,000 for seed. Majority (156) of them spend below ₹5,000 for pesticides and 38 respondents spend above ₹10,000. But in the labour cost a considerable proportion (144) of the respondents spend ₹5,000-10,000 for their cultivation and 72 of them spend minimum for the labour. Bulk of sample respondents (164) spends less than ₹5,000 for irrigation but only 44 of them spend above ₹10,000. Nearly two third of the respondents (207) spend below ₹5,000 for ploughing for their land and 37 of them spend above ₹10,000.

4. PATTERN OF FERTILIZER CONSUMPTION BY RESPONDENTS

1) Crop wise fertilizer consumption

A major objective of the study was to assess the pattern of fertilizer consumption. For each crop the fertilizer need is different. The crop wise fertilizer consumption is presented in table 18.

The major crops raised in the area are turmeric, maize, sugarcane, pulses, paddy, flowers and other crops. The consumption of total fertilizer was highest for sugarcane (233.67 kg / acre) which N accounted 61 percent, which K and P had a share of 25 percent and 13 percent. Next in line was Maize with 139.18 Kg. The share of N, P and K was 56 percent, 23 percent and 19 percent respectively. The fertilizer consumption was least for flower with only 39.88 Kg.
In the case of N,P and K fertilizer, respectively shared 34 percent, 33 percent, and 32 percent. Almost all the crops needed excess N fertilizer and less than recommended level P and K fertilizer. High profit crops like sugarcane, rice, turmeric and tapioca needed excess fertilizers. The finding of the study by Velrasu and Singh (1999) is in line with the current study.

The quantity of fertilizer used by the farmers for various crops is given in Table 19.

It was found that majority (50.7 percent) of the sample respondents used 250 kg to 500 kg of fertilizers for their farming, 20 percent of them used above 500 kg. High profit crops like turmeric, rice, sugarcane and coconut required more fertilizers. Some of the reasons for non-adoption of recommend does of fertilizers were inadequacy of incremental returns no knowledge of crop- wise recommended dose of fertilizer, lack of capital, lack of assured rainfall / irrigation facilities and inadequate availability of fertilizers. As most of the Indian farms rain fed and there by the dosage of fertilizers varies from year to year according to the change in the rainfall pattern.

2) Income from crops

Balanced and adequate fertilization is essential for increasing crop yields and ensuring sustainable agriculture. No developed or developing country in the world has been able to increase agricultural production without expanding the use of balanced fertilization. In fact, in countries where consumption of plant nutrients is low and imbalanced, agricultural production is also low, and yields are stagnant or declining. Indian farmers are no exception to this phenomenon. (Dev 1998, Vats et al 1999, Subbiah and Kumaraswamy 2000, Muralidharuduand Tandon 2010). The use of fertilizer has led to increase in production resulting in the increase in the income of the famers. This is reported in Table 20.

Majority of the sample respondents (44.7 percent) earned an income of ? 20,000-40,000, from agricultural production by using fertilizers, 34 percent of them received below ? 20,000 and only 21.3 percent of the respondents had an income above ? 40,000.

5. BRAND PREFERENCE AND REASONS FOR USING DIFFERENT BRAND OF FERTILIZERS
Fertilizer industry is of oligopolistic type of industry where only a few big players, both public and private company own the industry. Some of the major players in the fertilizer industry are FACT -Cochin, SPIC-Tuticorin KRIBHCO -Hazira and Gorakhpur, IFFCO- Kalol and Kandla etc. The respondents reference towards these fertilizers are given in Table 21.

The data reveal that a larger proportion of sample respondents preferred FACT brand of fertilizers, 22.7 percent of them have a preference for IFFCO, 11 percent of them used Vijay and KRIBHCO fertilizers and 4.0 percent of them preferred using other fertilizer like Selavavas, Indian potash and TAC.

According to the respondent farmers the reasons for using a particular brand of fertilizer are given in Table 22.

Various reasons for using the above branded fertilizer is presented in table - 22. Majority (33.6 percent) of the sample respondents used fertilizers for an increase in yield, 20.3 percent of them used fertilizers due to its better quality and 17.5 percent for lower price, 6.9 percent of them used these fertilizer because it is well suited for the soils and 12.5 percent of them stated its easy availability.

Fertilizer being the main ingredient used in agricultural production the investigator was interested to find out the awareness of farmer about the fertilizer. The details collected with regard to this are presented in Table 23.

In this study, majority of the sample respondents got awareness about the fertilizers through relatives / friends and dealers because they had lot of experience in utilization of fertilizers and its capacity. The study made by Ramand and Anand (2009) also gave the same result. About 16.3 percent of them obtained through progressive farmers, 14 percent got knowledge from the co-operatives, 11 percent through media; 10.3 percent got information from the department of agriculture and 9 percent of them understood the usage of fertilizers from magazine.
Almost 39.7 percent of the sample respondents purchased fertilizers from co-operative society; 32.3 percent purchased through dealers and 27.7 percent purchased the fertilizer through the department of agriculture. The mode of payment for the fertilizer was either in cash or credit or at times both. Around 54 percent made payment in the form of credit and only 27 percent could make payment in cash. Farmers as we know do not hold liquid cash always and hence find it difficult to pay. There were 17 percent who used either cash or credit payment. Availability of fertilizers on credit was the most important factor influencing the farmers to purchase from a specific source said Ramesh and Anand (2009).

6. SATISFACTION LEVEL OF THE RESPONDENTS

1) Satisfaction level of the fertilizer usage

The sample respondents were asked to give their satisfaction level on fertilizer usage on a five point rating scale. The analysis of weighted average method is shown in the Table 24

Table 24 confirms that, the mean value obtained is 3.74 for product availability, 3.71 for convenience in area, 3.60 for sales service, 4.03 for price of fertilizers, 3.55 for quality, which is 4 and greater than 3, hence it is remarked that majority of the respondents agree all these opinion and 3.17 for package, 3.22 for quantity, which is lesser than 4, hence it is concluded that, respondents had a neutral opinion of package and quantity of fertilizers.

Factor analysis was used in the study to identify the pattern of satisfaction level and determinants of fertilizer usage by the sample respondents and whether these dimensions can be grouped in terms of a composite variable.

To determine the appropriateness by applying factor analysis the Kaiser Meyer Olkin (KMO) and Bartlett's test measures were computed and is given in table 25.
KMO statistics is 0.858 simplifying higher than acceptable adequacy of sampling. The Bartlett's test of sphericity was also found to be significant at one percent level providing evidence of the presence of relationship between variables to apply factor analysis.

The communalities for each variable were computed to determine the amount of variance accounted by the variables to be included in the factor rotations and the results are shown in Table 26.

All the variables had values greater than 0.50 signifying substantial portion of the variances accounted by the factors.

Table 27 shows the Eigen values, their relative explanatory powers and factor loadings for 9 linear components identified within the data set. The Eigen value greater than one alone was considered for inclusion in the analysis.

The Kaiser rotated component matrix presented in table 27 shows that factor one had significant loadings for four dimensions namely product availability, price, quantity and quality. Factor one was very powerful accounting for 66 percent of the variance. Factor two had significant loadings three dimensions namely Convenience in area, Sales service and Package weight. Factor two explains 17 percent of the variance.

In order to investigate the relationship between the level of satisfaction of fertilizer user and farming experience of the sample respondents, Pearson's chi-square test was done. The null hypothesis framed was:

$H_0$: The level of satisfaction is independent of the farming experience of the sample respondents.

$H_a$: The level of satisfaction is not independent of farming experience of the sample respondents.

The calculated chi-square values are shown in table 28.

The study found significant association between the level of satisfaction and farming experience of the sample respondents. The decision to use fertilizers at the farmer’s level is a complex process. To start with, the farmers
have to decide whether or not to use fertilizers and it then follows the decisions of which crops to be fertilized and at what rates. It was found that in many cases, this decision making skill is based on the farming experience of the growers.

2) **Estimation of satisfaction level towards suppliers**

The sample respondents were asked to give their satisfaction level on their fertilizer suppliers on a five point rating scale. The analysis as revealed in the weighted average method is shown in the Table 29

The Table 29 confirms, the mean value obtained is 3.62 for information on fertilizers, 3.67 for Price details, 3.74 for adequate stock, 3.60 for price of fertilizers, 3.85 for availability of fertilizer, 3.87 for credit facility, 3.74 for customer service, which is greater than 3, hence it is remarked that, majority of the respondents agree all these estimation and 3.43 for advertisement, hence it is concluded that, respondents had neutral opinion of advertisement of fertilizers.

Factor analysis was applied to determine the underlying pattern of relationship between various dimensions of the respondent's satisfaction with the supplier and find whether these factors can be grouped in terms of a composite variable. The Cronbach's alpha was estimated to be 0.839 indicating the reliability of the scale used for evaluating the opinion of the sample respondents. To determine the appropriateness of applying factor analysis the KMO and Bartlett's test measures were computed and the results are presented in Table 30

To determine the appropriateness by applying factor analysis the Kaiser Meyer Olkin (KMO) K statistics was 0.746 simplifying higher than acceptable adequacy of sampling. The Bartlett's test of Sphericity was also found to be significant at one percent level providing evidence of the presence of relationship between the variables to apply factor analysis.
The communalities for each variable were assessed to determine the amount of variance accounted by the variable to be included in the factor rotations and the results are shown in Table 31.

All the variables have a value exceeding 0.5 signifying substantial portions of the variance in the variables accounted by the factors.

Table 32 enlists the Eigen value, their relative explanatory powers and factor loadings for ten linear components identified within the data set.

The Kaiser rotated component matrix presented in Table 36 reveals that, factor one had significant loadings on four dimensions namely, information on fertilizers, quality fertilizers, credit facility and customer service. Factor one was very powerful because it explains 44 percent of the variance. Factor two had significant loadings on two dimensions namely, price details and availability of fertilizer. It explains only 15 percent of the variance. Factor three had significant loadings on two dimensions namely, adequate stock and advertisement.

It explains only 10 percent of the variance. Sarup and Pandey (1982) point out that enlarging the supply of credit through the co-operatives and bank channels, intuitional effects were needed in the production of food grains and optimal utilization of irrigation water. Such measures could help a great deal in persuading the farmers to adopt the modern technology on their farms and to reap good harvest.

7. **PROBLEMS IN USAGE OF FERTILIZER**

Farmers were facing various types of problem namely, non-availability of fertilizer (supply shortage), no timely supply, higher price, long distances of outlets from the farmers' fields, difficulty in application, adulteration, non-availability of credit, to get fertilizer etc. These are presented in Table 33
Majority of the farmers indicated that the most important problem faced was lack of credit and lengthy procedure to get the credit (1\textsuperscript{st} rank). The second most (2 rank) important problem was higher prices of the fertilizer followed by promptness of fertilizer (3\textsuperscript{rd} rank). Some of the other problems faced by the farmers included non-availability of fertilizers (supply shortages at the time of sowing) (4\textsuperscript{th} rank), long distance of the outlets from the farmers location (5\textsuperscript{th} rank), risk of crop loss due to erratic rainfall (6\textsuperscript{th} rank), fertilizer adulteration (7\textsuperscript{th} rank), difficulty in application due to faulty packing (8\textsuperscript{th} rank) and the formation of lumps in the fertilizer bags (9\textsuperscript{th} rank) and lastly the continued degradation of soil year after year due to fertilizer application (10\textsuperscript{th} rank). Similar observation was also reported by Ramesh and Anand (2007).

8. **DETERMINANTS OF FERTILIZER USE IN THONDAMUTHUR BLOCK**

The multiple regression analysis was carried out for estimating the influence of factors on fertilizer consumption. Table 34 shows the result of multiple regressions.

The $R^2$ value of 0.64 indicates that the fit was good that is, 64 percent of the variation in fertilizer use was caused by six explanatory variables. All independent variable, except cost of Ploughing and cost of labours were statistically significant and positively related with fertilizer consumption. Variables like, price of fertilizer, cost of irrigation, farm size and income from crop production had greater influence on the determination of fertilizer consumption. It implies that, one unit increase of these variables is capable of increasing fertilizer consumption by 0.071, 0.077, 0.331 and 0.061 units respectively. F value emerged statistically significant at 1 percent level. Thus it may be inferred that the overall regression model was statistically significant.
9. OPINION OF THE RESPONDENTS ABOUT FERTILIZERS

Among all the strategic inputs, fertilizer plays a key role in modern agriculture. Fertilizer has been universally accepted as an integral part for raising Indian agriculture to a higher technological plank. It is estimated that fertilizers in association with water can enhance output by about 70 per cent. Nearly 50 per cent of the increased food grain productions in the last decade in the world come from the increased use of fertilizers (Borlaug, 1996). It is accepted that fertilizer is an expensive agricultural input and therefore, its efficient use is indispensable for reducing the cost per unit of agricultural produce. During Kharif season, rice is the major crop which accounts for bulk of fertilizer consumption and if the fertilizer consumption has to be increased along with the productivity of rice. The survey made an attempt to study the opinion of farmers in using fertilizers. Their opinions are listed in Table 35.

Majority of the sample respondents (51 percent) had used the organic manure for their farming and 49 percent of the sample respondents had not used any organic manure.

Most of the sample respondents (48 percent) revealed that they have used the bio fertilizer for their farming and remaining 52 percent of the respondents have not used the bio fertilizer for their agriculture land.

According to Ramesh and Anand (2007), some of the reasons for non-adoption of recommended dose of fertilizers were inadequacy of incremental returns, no knowledge of crop wise dose of fertilizer, lack of capital, lack of assured rainfall/irrigation facilities and inadequate availability of fertilizers. As most of the Indian farms are rain fed and there by the dosage of fertilizers varies from year to year according to the change in the rainfall pattern. From the data, it is evident that, 58 percent of the sample respondents had applied the recommended quantity of fertilizer and 42 percent of the sample respondents have not applied the recommended quantity of fertilizer.
Ramand and Anand (2009) also reported that, almost all the farmers purchase fertilizer in the month of June and October (sowing time) and August and December (for top dressing) 70.7 percent of the respondents reported that organic fertilizer is better than chemical fertilizer while 29.3 percent of the respondents did not agree with this view.

The mainstream of the sample respondents (54.7 percent) agree that they have obtained maximum possible yield by the use of fertilizers and 45.3 percent of the sample respondents did not agree with this view. In this study, 52.3 percent of the sample respondents reported that the increase in fertilizer price has not affected the consumption of fertilizer. Fertilizer is price inelastic. Similar observation was reported by Kayarkanni (2000). However 47.7 per cent of the sample respondents agree that an increase in fertilizer price do affect the consumption of fertilizer.

Majority (57.7 percent) of respondents have no storage facilities, farmers purchase fertilizer as and when required and use almost the entire quantity of fertilizer at a time to avoid the risk of quality and quantity loss during storage. Remaining 42.3 percent of the sample respondents had storage facilities. Similar results were cited by Ramand and Anand (2009).

It was evident that bulk of the sample respondents (121 respondents) have availed loan for fertilizer purchase and remaining 179 respondents have not availed any loan for fertilizer purchase.

Most of the sample respondents (191 respondents) have attended training for the usage of fertilizer and 109 respondents have not attended any training of such type.

It was apparent from the above data that, 38.7 percent of the sample respondents have received service from agricultural university and 61.3 percent of the sample respondents have not yet received services from agricultural university. Around 74.7 percent have never received any service from the government for their farming.
On the whole the respondents felt that fertilizer should be given at a lesser cost and at the right time. All of them are accord recommended for a reduction in the price of fertilizer. It was further felt that with more education the farmers would be able to use the latest know how in the application of fertilizer in their fields which would bring forth greater returns from land.