CHAPTER IV

RESULTS AND DISCUSSION

The result of the study **"Climate Change and Crop Diversification in Selected Study Blocks of Coimbatore District "** is presented and discussed under the following heads.

4.1. General Profile of Selected Farm Households

- 4.1. a. Consumption Expenditure

4.2. Land Use Pattern

- 4.2. a. Type of Land
- 4.2. b. Type of Soil
- 4.2. c. Details of Labour Usage
- 4.2. d. Details of Input Usage

4.3. Water Resources

- 4.3. a. Type of Wells
- 4.3. b. Type of Irrigation
- 4.3. c. Soil and Water Conservation Measures

4.4. Cropping Pattern

- 4.4. a. Details of Livestock

4.5. Problem of Farmers

- 4.5. a. Problem of Climate Change
- 4.5. b. Scaling Technique

4.6. Concept of Crop Diversification

4.7. Technical Efficiency

- 4.7. a. Input and Output of Agriculture Crops in Selected Farm households
- 4.7. b. Determinants of Technical Efficiency

4.8. Agriculture Loan/ Agriculture Credit System

4.9. Details of ICTs

- 4.9. a. Usage of ICTs

4.1. General Profile of Selected Farm Households

In a traditional and structural society, socio- economic factors play a significant role in shaping the personality and characteristics of an individual. The general belief in that the social environment is a combination of factors such as religion, caste, type of family, size of family, age and marital status, while economic environment is made up of factors such as education, employment status and total family income. An attempt is made to portray the socio-economic background of farm households.

Table-36
General Profile of Selected Farm Households

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
SEX									
Male	N	186	56	11	253	172	48	9	229
	C	80.52	66.67	73.33	76.67	72.27	61.54	64.29	69.39
Female	N	45	28	4	77	66	30	5	101
	C	19.48	33.33	26.67	23.33	27.73	38.46	35.71	30.61
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
Age									
20-30	N	4	2	0	6	1	3	0	4
	C	1.73	2.39	0.00	01.82	00.42	03.85	00.00	01.21
30-40	N	23	11	2	36	16	9	1	26
	C	9.96	13.09	13.33	10.91	06.73	11.54	7.14	07.88
40-50	N	76	28	4	108	73	23	3	106
	C	32.90	33.33	26.67	32.72	30.67	29.48	21.43	32.12
50 and above	N	128	43	9	180	148	43	10	194
	C	55.41	51.19	60.00	54.55	62.18	55.13	71.43	58.79
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
Education									
Illiterate	N	1	0	0	1	8	2	1	11
	C	0.43	0.00	0.00	0.30	3.36	2.56	7.14	3.33
Primary	N	138	48	10	196	174	51	11	236
	C	59.74	57.15	66.67	59.39	73.11	65.38	78.57	71.52
Higher Secondary	N	78	32	2	112	53	24	1	78
	C	33.78	38.09	13.33	33.95	22.27	30.77	7.14	23.64
UG	N	8	2	1	11	3	1	0	4
	C	3.46	2.38	6.67	3.33	1.26	1.28	0.00	1.21
PG	N	5	1	1	7	0	0	1	1
	C	2.16	1.19	6.67	2.12	0.00	0.00	0.00	0.30
Diploma	N	1	1	0	2	0	0	0	0
	C	0.43	1.19	0.00	0.61	0.00	0.00	0.00	0.00
PG and above	N	0	0	1	1	0	0	0	0
	C	0.00	0.00	6.67	0.30	0.00	0.00	0.00	0.00
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Cont.,

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Marital Status									
Married	N	227	81	13	321	235	75	12	322
	C	98.27	96.43	86.66	97.27	98.74	96.15	85.72	97.58
Unmarried	N	4	1	1	6	2	1	0	3
	C	1.73	1.19	6.67	1.82	0.84	1.28	0.00	0.91
Widow	N	0	2	1	3	1	2	1	4
	C	0.00	2.38	6.67	0.91	0.42	2.56	7.14	1.21
Divorced	N	0	0	0	0	0	0	1	1
	C	0.00	0.00	0.00	0.00	0.00	0.00	7.14	0.30
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
Type of Family									
Nuclear family	N	198	64	12	274	202	59	12	273
	C	85.71	76.19	80.00	83.03	84.87	75.64	85.71	82.73
Join family	N	33	20	3	56	36	19	2	57
	C	14.29	23.81	20.00	16.97	15.13	24.36	14.29	17.27
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
Religion									
Hindu	N	214	81	14	309	228	71	13	312
	C	92.64	96.43	93.33	93.64	95.80	91.03	92.86	95.54
Muslim	N	5	1	0	6	4	2	0	6
	C	2.16	1.19	0.00	1.82	1.68	2.56	0.00	1.82
Christian	N	8	2	1	11	6	5	1	12
	C	3.46	2.38	6.67	3.33	2.52	6.41	7.14	3.64
Other religion	N	4	0	0	4	0	0	0	0
	C	1.73	0.00	0.00	1.21	0.00	0.00	0.00	0.00
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
Community									
SC	N	46	15	0	61	38	13	0	51
	C	19.91	17.86	0	18.48	15.97	16.67	0	15.45
ST	N	26	11	0	37	24	11	0	35
	C	11.25	13.09	0	11.21	10.08	14.10	0	10.61
OBC	N	126	42	11	179	146	42	12	200
	C	54.54	50.00	73.33	54.24	61.34	53.85	85.71	60.61
OC	N	33	16	4	53	30	12	2	44
	C	14.29	19.04	26.67	16.06	12.60	15.38	14.29	13.33
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
Occupation									
Cultivators	N	42	23	4	69	29	19	5	53
	C	18.18	27.38	26.67	20.91	12.18	24.36	35.71	16.06
Agriculture labourers	N	180	56	10	246	201	56	9	266
	C	77.92	66.67	66.67	74.54	84.45	71.79	64.29	80.61
Other workers	N	9	5	1	15	8	3	0	11
	C	3.90	5.95	6.66	4.55	3.37	3.85	0.00	3.33
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Cont.,

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Annual Income									
Up to 50,000	N	102	36	2	140	99	30	1	130
	C	44.16	42.86	13.33	42.42	41.60	38.46	7.14	39.39
50,001-1,00,000	N	121	47	6	174	131	46	4	181
	C	52.38	55.95	40.00	52.73	55.04	58.97	28.57	54.85
1,00,001-1,50,000	N	8	1	5	14	8	2	8	18
	C	3.46	1.19	33.33	4.24	3.36	2.56	57.14	5.46
Above 1,50,001	N	0	0	2	2	0	0	1	1
	C	0.00	0.00	13.33	0.61	0.00	0.00	7.14	0.30
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019) N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF-Large Farmers, UG-Under graduate, PG- Post graduate, SC- Schedule caste, ST- Schedule Tribe, OBC- Other backward class, OC-Other community.

The general profile of the sample households are given in table- (36). For a concise presentation of the information collected from the respondents are classified on the basis of land holdings into three categories namely, Small farmers from Thondamuthur and Annur blocks, Medium farmers from Thondamuthur and Annur blocks, Large farmers from Thondamuthur and Annur blocks. A total of 660 farm households were surveyed of with 330 (50 per cent) were from Thondamuthur block and the remaining 330 (50 per cent) from Annur block.

Community has a particular feature of the Indian society determining the status of the members on the basis of birth and in prescribing their corresponding role. Community wise analysis reveals that both in the Thondamuthur and in the Annur blocks, OBCs constitute a major proportion with 54.24 and 60.61 per cent respectively. The farm households are mostly headed by males, the percentages being 76.67 in the Thondamuthur block and 69.39 in the Annur block.

Household size assumes significance of large households since the pressure of meeting the economic burden force in to small family norms; the farm households in both the blocks follow small family norms. The average size of a family in the Thondamuthur block and in the Annur block is three in each. But the large farmers in both the blocks have their average family size exceeding three. The breakdown of joint family system in India is revealed in the current study also. Nuclear family system is practiced among 83.03 per cent of the farm households in the Thondamuthur and 82.73 per cent of the farm households in the Annur blocks. Most of the small farmers follow nuclear family system both in the

Thondamuthur (85.71 per cent) and Annur blocks (84.87 per cent). The percentages are 76.19 and 75.64 among the medium farmers in the Thondamuthur and Annur blocks respectively. A significant deviation is seen among the large farmers in the Thondamuthur block. The analysis thus reveals mixed findings.

The data on the age of the head of the farm households in both the blocks reveals that about 30 to 40 per cent of the families of the small and medium farmers are in the age group of 40 to 50 years. But, 60 to 70 per cent of the families of the large farmers in both the blocks are in the age group of 50 plus.

Education is the basic for all individuals to improve their knowledge which helps to survive in the society, the percentage of farmers with no formal education is 0.30 in the Thondamuthur block and 3.33 in the Annur block. In both the blocks nearly 59 to 71 per cent of the head of the families had either primary or middle school education. Another 23 to 33 per cent had either high school or higher secondary education. Less than 5 per cent of the sample farmers had completed higher education.

Information related to the marital status of selected farm households, nearly 97 to 100 per cent of the farmers are married. Among the 660 farmers under study, only nine farmers in both the block were unmarried.

Occupation is essential for survival to earn for livelihood of individuals. The Coimbatore district has recorded 3rd lowest percentage of agriculture labourers to total workers in the districts (Census, 2011). The occupation of the farmers was higher in the percentages of 74.54 and 80.61 were agriculture labourers in which major proportion of 77.92 per cent and 84.45 per cent of small farmers and more than 60 per cent of where by medium and large farmers in both the blocks respectively.

The level of income is an important factor indicated economic welfare. Hence analysis of income becomes the key stone of any comprehensive study. The study reveals that the majority of the farm households come under the income group up to Rs 50,001 to Rs 1, 00,000, the percentage of 52.73 and 54.85 respectively. The percentages of 42.42 and 39.39 households have their income of below Rs 50,000 and Rs 1, 00,001 to Rs 1, 50,000 of the percentage of 4.24 and 5.46 in both the blocks.

4.1. a. Consumption Expenditure

Consumption expenditure is considered that expenditure spent by a farm household on goods and services that are utilized to meet desires or requirement. The pattern of per farm household consumption expenditure of the selected farm households across the different types of farmers in the two selected blocks is in table- (37).

Table- 37

Details of Consumption Expenditure of the Selected Households

S.No	Expenditure	Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Food Items									
1	Rice	12.59	13.62	14.2	14.63	14.89	13.2	14.26	13.98
2	Wheat	3.89	3.21	4.03	4.23	3.98	3.65	4.01	3.64
3	Cereals	2.38	2.36	3.02	3.23	3.27	3.26	2.53	2.36
4	Pulses	3.69	3.26	3.19	3.12	2.56	3.12	3.42	3.12
5	Oil and Spices	8.63	8.36	9.63	9.62	8.69	9.63	9.99	10.01
6	Vegetables	11.23	13.62	12.3	15.23	12.53	13.26	13.21	13.23
7	Others	1.2	2.3	2	1.6	1	1	2.1	1.39
Total expenses for food items		48.37	43.61	46.73	48.37	51.66	46.92	47.12	49.52
Non Food Items									
8	Health	8.53	7.78	7.78	7.56	7.23	8.6	8.23	9.23
9	Clothing	6.32	7.53	7.53	5.23	6.32	7.81	7.23	6.98
10	Education	9.23	16.4	16.4	15.45	14.96	15.23	15.42	14.4
11	Shelter	4.61	3.65	3.65	3.02	4.12	4.27	4.13	4.23
12	Electricity	2.36	3.45	3.45	2.63	2.1	2.51	2.13	3.96
13	Fuel	10.23	12.23	12.23	10.23	11.03	11.2	11.02	10.36
14	Cosmetics	1.01	1.9	1.9	1.23	1.16	1.9	1.23	1.1
15	Communication and data card	3.34	3.45	3.45	2.99	3.56	1.36	3.69	2.01
Total Non-Food Items		51.63	53.27	56.39	48.34	50.48	52.88	53.08	52.27
Total Expenditure		100	100	100	100	100	100	100	100

Source: Field survey, (2019).

In the Thondamuthur block, regular household spending remained that the percentage spent on food items has 48.37 per cent and 43.61 per cent of small and medium farmers. Among the food items, 19 were expenses on rice. In the case of non-food expenditure, the households spent 48.34 per cent on nonfood items. In Annur block also a similar expenditure pattern prevailed. The percentage expenditure consumed on food items has the small farmers from 47.12 per cent to 49.52 per cent for medium farmers and large farmers from 46.92 per cent to 39.58 while 52.27 per cent on nonfood items.

4.2. Land Use Pattern

Agriculture land is typically the land devoted to agriculture, the systematic and controlled use of other forms of life particularly for the crop production and rearing livestock production (Palchoudhuri, 2015). The land is the basic resource for agriculture, a primary source of livelihood for majority of India's rural population. The following table- (38) shows the land use pattern in selected study area.

Table- 38

Details of Land Use Pattern in Selected Farm Households

(in hectares)

Particulars		Thondamuthur				Annur			
		SF	**MF**	**LF**	**ALL**	**SF**	**MF**	**LF**	**ALL**
Nature of Land									
Wet	**N**	93	38	7	138	34	15	2	51
	C	40.26	45.23	46.67	41.81	14.28	19.23	28.57	15.45
Dry	**N**	6	2	1	9	85	24	4	113
	C	2.59	2.38	6.67	2.73	35.71	30.77	14.29	34.24
Orchards	**N**	132	44	7	183	119	39	8	166
	C	57.15	52.38	46.67	55.45	50.00	50.00	57.14	50.30
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019) N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

The land was characterized as 'wet land', 'orchards' and 'dry land'. In the Thondamuthur block, the land owned and used, orchards constitutes the major proportion the percentage of 57.15 of small farmers, 52.38 per cent of medium farmers and 46.67 per cent of large farmers across all the types of farmers 55.45 per cent followed by wet land by 41.81 per cent of the farmers in which small farmers (40.26), medium farmers (45.23 per cent) and large farmers (46.67 per cent). Dry land constitutes a lesser percentage of 2.59 of small farmers and 2.38 of medium farmers and around 2.73 per cent of all type of farmers.

In the Annur block, on an average the farmers across all the groups own land in a larger measure compared to Thondamuthur block. The small farmers and, medium farmers (50 per cent) and large farmers (57.14 per cent) on an average in Annur block also, orchards constitutes a major proportion (50.30 per cent) followed by wet (15.45 per cent) with the small farmers (14.28 per cent), medium farmers (19.23 per cent) and dry land constitutes of 35.71 per cent of small farmers, 30.77 per cent of small farmers and 14.29 per cent of large farmers in which total farmers average of 34.25 per cent respectively.

4.2. a. Type of Land

Land ownership provides a sense of security to people in the rural areas while it also determines the economic condition by way of the social status of individuals. Indian agriculture is pre-dominated by small and marginal farmers. As land was the main factor in agriculture output majority of the farmers was owned land where some farmers have tenant lands for farming in the selected study area was shown in the following table- (39).

Table- 39

Details of Type of Land in Selected Farm Households

Particulars		**Thondamuthur**				**Annur**			
		SF	**MF**	**LF**	**ALL**	**SF**	**MF**	**LF**	**ALL**
Type of Land									
Own	N	152	52	13	217	141	48	11	200
	C	65.80	61.90	86.67	65.76	59.24	61.54	78.57	60.61
Tenant	N	78	30	1	109	97	29	2	128
	C	33.77	35.71	6.67	33.03	40.76	37.18	14.29	38.79
Both	N	1	2	1	4	0	1	1	2
	C	0.43	2.38	6.67	1.21	0	1.28	7.14	0.61
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Number of years of Farming									
Below 10 years	N	88	22	5	115	76	29	6	111
	C	38.09	26.19	33.33	34.85	31.93	37.18	42.86	33.64
Above 10 years	N	143	62	10	215	162	49	8	219
	C	61.90	73.81	66.67	65.15	68.07	62.82	57.14	66.36
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019) N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers..

Land details such as type of land and years of cultivation reveals that the percentage of farmers has their own farm land of 65.76 and 60.61 in Thondamuthur and Annur block. On an average small farmers own 65.80 per cent, medium farmers 61.90 per cent and large farmers 86.67 per cent of land in Thondamuthur block and in Annur block on an average the small farmer own 59.24 per cent, medium farmers 61.54 per cent and large farmers 78.57 per cent of land respectively. The most of the farmers involved in faming activities of more than ten years with the percentages of 65.15 and 66.36 in Thondamuthur and Annur block. The proportion of small, medium and large farmers as 61.90 per cent, 73.81 per cent and 66.67 per cent in Thondamuthur block while in Annur block 68.07 per cent of small farmers, 62.82 per cent of medium farmers and 57.14 per cent of large farmers respectively. The farmers in

both the blocks under tenant land occupies about 33.03per cent and 38.79 per cent while under both own and tenant lands occupied about percentage of 1.21 and 0.61 respectively.

4.2. b. Type of Soil

Soil is the main factor of agricultural production. As the soil was the main factor in agriculture production where maximum area of the selected blocks remained the red soil where some parts have covered by black soil and, alluvial soil in the study blocks is in the following table- (40).

Table- 40
Details of Type of Soil in Selected Farm Households

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Red	N	79	26	6	111	72	22	4	98
	C	34.20	30.96	40.00	33.64	30.25	28.20	28.57	29.70
Black	N	95	31	4	130	119	35	6	160
	C	41.13	36.90	26.67	39.39	50.00	44.87	42.86	48.48
Red Sandy	N	36	19	3	58	24	12	3	39
	C	15.58	22.62	20	17.58	10.08	15.39	21.43	11.82
Sandy coastal alluvium	N	21	8	2	31	0	0	0	0
	C	9.09	9.52	13.33	9.39	0	0	0	0
Calcareous	N	0	0	0	0	23	9	1	33
	C	0	0	0	0	9.67	11.54	7.14	10.00
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019) N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

Type of Soil in Selected Farm Households

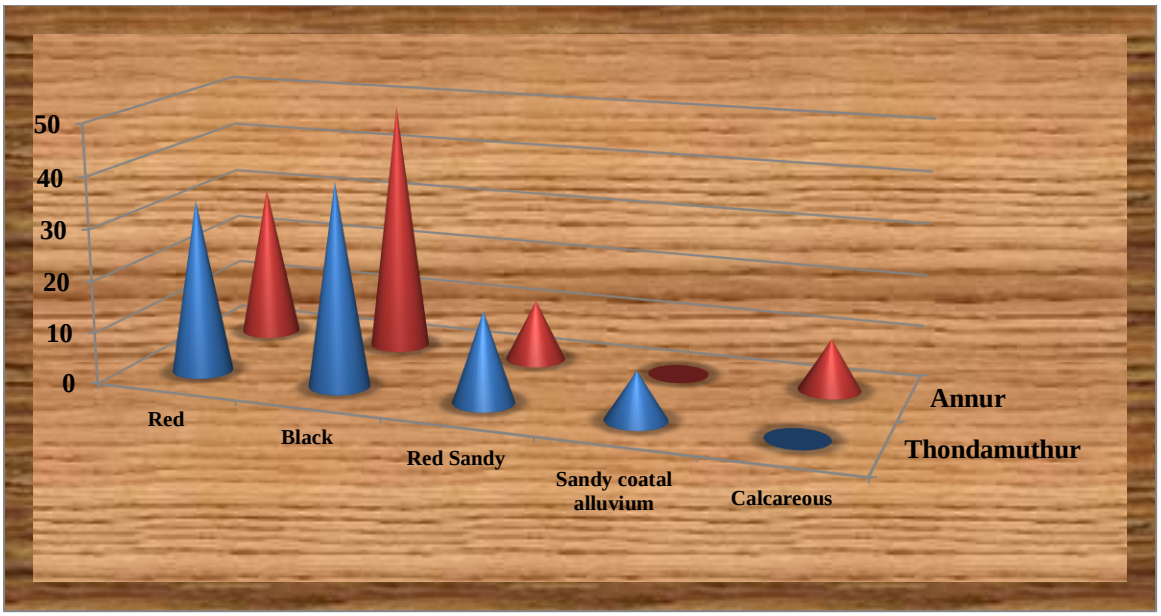

Figure: 10

Thondamuthur block is covered with red soil (33.64 per cent), black soil (39.39 per cent), red sandy (17.58 per cent) and sandy coastal alluvium (9.39 per cent). Annur block is covered with black soil (48.48 per cent) red soil (29.70 per cent) red sandy (11.82 per cent) and calcareous (10 per cent). In both Thondamuthur and Annur blocks covered with red and black soil. Red soil has iron content and is fit for crops like red gram, bengal gram, and green gram groundnut and caster seed. Black soil is rich in calcium, potassium and magnesium. Crops like cotton, tobacco, chilly, oilseeds, jowar, ragi and maize grow well in it.

4.2. c. Details of labour Usage

Agriculture labour can be refers to the person involved in connection with cultivating the soil or in connection with harvesting any agricultural commodity, management of livestock, bees, poultry, etc,. The details of agriculture labour participation in selected study area is given in the following table- (41).

Table-41

Details of Labour used in Agriculture Activities in Selected Farm Households

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Human Labour	N	162	43	7	212	153	36	6	195
	C	70.13	51.19	46.67	64.24	64.29	46.15	42.85	59.09
Bullock Labour	N	20	9	2	31	47	15	2	64
	C	8.66	10.71	13.33	9.39	19.75	19.23	14.29	19.39
Machine labour	N	49	32	8	89	38	27	6	71
	C	21.21	38.09	53.33	26.97	15.96	34.61	71.14	21.51
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019) N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers

The agriculture labour was categorized under human labour, bullock labour and machine labour. In Thondamuthur block the human labour is participated higher in the percentage of 64.24 where machine labour 26.97 per cent and bullock labour of least percentage of 13.33while in Annur block the human labour is participated higher in the percentage of 59.09 where machine labour 21.51 per cent and bullock labour of least percentage of 19.39 respectively. In both the blocks human labour is higher than the other labour participation.

4.2. d. Details of Input Usage

The agricultural growth experience of India since independence was essentially an outcome of the massive efforts aimed at ensuring availability and use of quality seeds, chemical fertilizers, irrigation, pesticides, farm machinery and equipment, agricultural credit, etc. Quality seeds are crucial for enhancing agricultural production. It is estimated that quality seeds contribute to around a quarter of the overall increase in productivity (State of Indian Agriculture 2015). Efficacy of all other agricultural inputs, such as fertilizers, pesticides and irrigation, etc., as well as impact of agro-climatic conditions on the crop, is largely determined by the quality of the seed used. In India the manufacture, sale, and distribution of fertilizers is regulated by the Ministry of Chemicals and Fertilizers, under the Essential Commodities Act, 1955 recommended the three major types of nutrients used as fertilizers: Nitrogen (N), Phosphatic (P), and Potassic (K). The level of fertilizer required for a crop depends upon the soil type, level of yield, and water availability, in addition to the different crops. Certain crops such as rice, wheat, maize, cotton, and sugarcane require larger quantities of nitrogen when compared to pulses, fruits, and vegetables. The ratio of N, P, and K fertilizer usage across crops has increased. The details of input usage in selected farm households are in the following table- (42).

Table- 42
Details of Input Usage in Selected Farm Households

Particulars		Thondamuthur				Annur			
		SF	**MF**	**LF**	**ALL**	**SF**	**MF**	**LF**	**ALL**
Fertilizers									
N	N	125	31	7	163	134	32	6	172
	C	54.11	36.90	46.67	49.39	56.30	41.02	42.86	52.12
P	N	45	21	3	69	59	18	3	80
	C	19.48	25.00	20.00	20.91	24.79	23.08	21.43	24.24
K	N	27	12	2	41	24	15	2	41
	C	11.69	14.28	13.33	12.42	10.08	19.23	14.28	12.42
Organic Manure	N	34	20	3	57	21	13	3	37
	C	14.72	23.81	20.00	17.27	8.82	16.67	21.43	11.21
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Type of Seeds Used									
Traditional	N	98	21	4	123	84	29	5	118
	C	42.42	25.00	26.67	37.27	35.29	37.18	35.71	35.76
HYV	N	133	63	11	207	154	49	9	212
	C	57.58	75.00	73.33	62.73	64.71	62.82	64.28	64.24
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Cont.,

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Fertility of Land									
Less fertile	N	71	39	4	114	84	31	5	120
	C	30.74	46.43	26.67	34.54	35.29	39.74	35.71	36.36
Fertile	N	84	29	6	119	95	19	4	118
	C	36.36	34.52	40.00	36.06	39.92	24.36	28.57	35.76
Highly fertile	N	69	11	3	83	54	22	3	79
	C	29.87	13.09	20.00	25.15	22.69	28.20	21.42	23.93
Infertile	N	7	5	2	14	5	6	2	13
	C	3.03	5.95	13.33	4.24	2.10	7.69	14.28	3.93
	N	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
All	**C**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019) N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

The input dosage and primarily on what recommendation farmers carry their farming practices. The majority of farmers under the usage of fertilizers where N is 49.39 per cent, 52.12 per cent next to P accounts for 20.91 per cent and 24.24 per cent where usage of K is 12.42 per cent both the blocks where the usage of organic manure is 17.27 per cent and 11.21 per cent in both the blocks.

The majority of farmers where the seeds usage the average being 37.27 per cent of Traditional seeds and High yielding varieties of seeds account for 62.73 per cent in the Thondamuthur block. In Annur block the Traditional variety seeds and High yielding varieties of seeds account for 35.76 per cent and 64.24 per cent.

The fertility of land reveals the less fertile land is 34.54 per cent fertile land is 36.06 per cent, high fertile land is 25.15 per cent and, the infertile land is 4.24 per cent in the Thondamuthur block. The average of 36.36 less fertile lands followed by fertile land is 35.76 per cent, high fertile land is 23.93 per cent, and infertile land is 3.93 per cent in Annur block. The analysis stated that fertile land is higher when compared to infertility land by using the proper input usage in selected farm households. The study reveals that in both the blocks the farmers highly used the N of fertilizer of using the higher-yielding varieties of seeds in the fertile land.

4.3. Water Resources

Water is a critical input into agriculture in nearly all its aspects having a determining effect on the eventual yield. India accounts for about 2.45 per cent of the world's surface area, 4 per cent of the world's water resources, and about 16 per cent of the world's population. The total water available from precipitation in the country in a year is about 4,000

cubic km. The availability of surface water and replenish able groundwater is 1,869 cubic km, (National Water Policy, 2002). The total utilizable water resource in the country is only 1,122 cubic km. The mean annual flow in all the river basins in India is estimated to be 1,869 cubic km.

Table- 43

Details of Water Resources in Selected Farm Households

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Canal	N	60	30	5	95	0	0	0	0
	C	25.97	35.71	33.33	28.79	0	0	0	0
Wells/Tubewells	N	171	54	10	235	206	52	10	268
	C	74.03	64.29	66.67	71.21	86.55	66.67	71.42	81.21
Lakes	N	0	0	0	0	32	26	3	61
	C	0	0	0	0	13.45	32.05	21.43	18.48
Others	N	0	0	0	0	0	1	1	2
	C	0	0	0	0	0	1.28	7.14	0.61
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019) N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

The above table – (43) shows the water resources of selected farm households where the type of wells contribution of the canal is 28.79 per cent and 71.21 per cent of wells where there are no lakes and other water sources in Thondamuthur block. In the Annur block, there is the absence of canals while wells account for 81.21 per cent, lakes of 18.48 per cent, and other water sources of 0.61 per cent.

4.3. a. Type of Wells

India's total annual replenish able groundwater resource is around 433 billion cubic meters (BCM) under net-annual groundwater availability is 398 BCM in which India withdraws 245 BCM (62 per cent) annually. Groundwater irrigation in India remains highly inefficient from a technical point of view. For example, India's third Minor Irrigation Census has shown that in 2001, only 3 per cent of India's some 8.5 million tube-well owners used drip or sprinkler irrigation and 88 per cent delivered water to their crops by flooding through open channels (Water and Agriculture in India, 2017).

Table- 44
Details of Type of Wells in Selected Farm Households

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Types of Wells									
Open well	N	91	34	5	130	100	28	4	132
	C	39.39	40.48	33.33	39.39	42.01	35.90	28.57	40.00
Bore well	N	102	35	8	145	112	32	6	150
	C	44.16	41.67	53.33	43.93	47.06	41.02	42.86	45.45
Open with bore well	N	38	15	2	55	32	18	4	54
	C	16.45	17.86	13.33	16.67	13.44	23.08	28.57	16.36
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Distance Covered from the Water Resources to Agriculture Land									
Less than 2 km	N	112	42	9	163	154	36	8	198
	C	48.48	50	60.00	49.39	64.71	46.15	57.14	60.00
2-5 km	N	86	31	4	121	52	29	5	86
	C	37.23	36.90	26.67	36.67	21.85	37.18	35.71	26.06
Above 5 km	N	33	11	2	46	32	13	1	46
	C	14.29	13.09	13.33	13.94	13.44	16.67	7.14	13.94
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019) N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

Type of Wells in Selected Farm Households

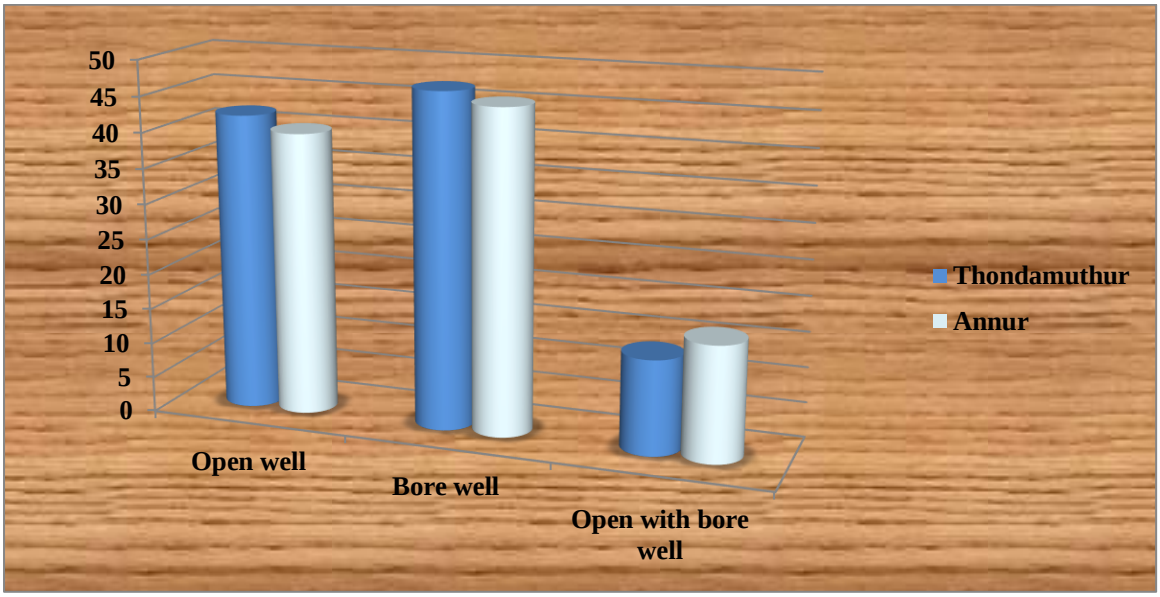

Figure: 11

The above table – (44) shows that water sources of selected farm households where the type of wells contribution of the open well is 49.09 per cent while bore well is 39.39 per cent under by both open well with bore well is 11.51 per cent in Thondamuthur block and

Annur block reveals that open well is 54.24 per cent where bore well is 32.42 per cent under by both open with bore well is 13.33 per cent respectively. The detail on the distance covered from the water resources to agriculture land compiled that less than 2 km is 60 per cent in both the blocks while compared the distance from above 5 km respectively. Thus from the identified the bore well is largely used by the farmers with lesser using distance of fewer than two kilometers.

4.3. b. Types of Irrigation

The efficiency of water use must improve to expand the area under irrigation while also conserving water. In agriculture, water is mainly used for irrigation. Irrigation is needed because of Spatio-temporal variability in rainfall in the country (National Water Policy 2002). Hence, it is difficult to practice agriculture without assured irrigation during dry seasons. Provision of irrigation makes multiple cropping possible. The Economic Survey 2015-16 observed that India is higher using the technique of flood irrigation, where water is allowed to flow in the field and seep into the soil. The wastage water since excess water seeps into loam or runs on the surface without being utilized. The recommended that farmers could move from flood irrigation to drip or sprinkler irrigation systems (micro-irrigation). Conserving water would save the cost of irrigation (State of Indian Agriculture, 2016). Using micro-irrigation systems (such as drip or sprinkler irrigation) has also been linked to an increase in the yield of crops (Hans, 2010).

Table- 45

Details of Types of Irrigation in Selected Farm Households

Particulars		**Thondamuthur**				**Annur**			
		SF	**MF**	**LF**	**ALL**	**SF**	**MF**	**LF**	**ALL**
Drip Irrigation	N	87	29	5	121	96	38	4	138
	C	37.66	34.52	33.33	36.67	40.34	48.72	28.57	41.82
Sprinkler Irrigation	N	64	19	2	85	57	22	4	83
	C	27.71	22.62	13.33	25.76	23.95	28.20	28.57	25.15
Canal	N	12	8	2	22	2	0	0	2
	C	5.19	9.52	13.33	6. 67	0.84	0	0	0.61
Surge	N	15	6	1	22	19	2	2	23
	C	6.49	7.14	6. 67	6. 67	7.98	2.56	14.28	6.97
Flood Irrigation	N	8	5	3	16	3	5	1	9
	C	3.46	5.95	20	4.85	1.26	6.41	7.14	2.73
Tube well	N	45	17	2	64	61	11	3	75
	C	19.48	20.23	13.33	19.39	25.63	14.10	21.43	22.73
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019) **N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.**

The details of the type of irrigation practiced by the farmers is showed in the table-(44) in which usage of drip irrigation is higher in the per cent of 36.67 per cent and 41.82 per cent when compared to other form irrigation activities in both the Thondamuthur and Annur blocks.

4.3. c. Soil and Water Conservation Measures

Soil and water have always been vital for sustaining life and becoming more limited as the population increases. Soil and water conservation practices are the primary steps of the watershed management program. These practices protect land degradation, improve soil health, and increase soil-moisture availability and groundwater recharge. The following table-(46) shows the soil and water conservation in selected blocks.

Table- 46

Soil and Water Conservation Measures in Selected Farm Households

Particulars		**Thondamuthur**				**Annur**			
		SF	**MF**	**LF**	**ALL**	**SF**	**MF**	**LF**	**ALL**
Water Conservation Measures									
Farm Pond	N	121	45	10	176	148	54	12	214
	C	52.38	53.57	66.67	53.33	64.07	64.29	80	64.85
Percolation pond	N	76	21	7	104	93	29	8	130
	C	32.90	25.00	46.67	31.52	40.26	34.52	53.33	39.39
Renovation of tank	N	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0
Rejuvenation of wells	N	18	18	5	41	23	25	7	55
	C	7.79	21.43	33.33	12.42	9.96	29.76	46.67	16.67
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
Soil Conservation Measures									
Summer ploughing	N	54	24	3	81	51	19	3	73
	C	23.38	28.57	20.00	24.54	21.43	24.36	21.43	22.12
Contour bunding	N	62	21	4	87	64	23	5	92
	C	26.84	25.00	26.67	26.36	26.89	29.49	35.71	27.88
Land leveling	N	79	23	5	107	81	21	4	106
	C	34.20	27.38	33.33	32.42	34.03	26.92	28.57	32.12
Others Conservation	N	36	16	3	55	42	15	2	59
	C	15.58	19.05	20.00	16.67	17.65	19.23	14.29	17.88
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**

Source: Field Survey, (2019), N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

The water and soil conservation measure is important for increase in crop production. In Thondamuthur block of 53.33 per cent and in Annur 64.85 per cent of farm pond under water conservation measures and in Thondamuthur block 32.42 per cent and 32.12 per cent of land leveling under the soil conservation measure. Thus, in both the blocks the soil and water conservation measures is practiced more than two times in a year. Thus the practice of soil and water conservation measures would help to increase the crop production.

4.4. Cropping Pattern

A cropping pattern means the proportion of area under different crops at a particular point in time. In India, a large proportion of the area occupied cereals as 3.6 per cent and pulses as 5.9 per cent (Economic survey, 2015). The table- (47) shows the details of cropping pattern in the selected farm households.

Table- 47

Details of Cropping Pattern in Selected Farm households

S.No	Particulars		Thondamuthur				Annur			
			SF	MF	LF	ALL	SF	MF	LF	ALL
1	Cereals	N	22	12	1	35	30	7	1	38
		C	9.52	14.29	6.67	10.61	12.60	8.97	7.14	11.51
2	Pulses	N	28	11	2	41	25	4	1	30
		C	12.12	13.09	13.33	12.42	10.50	5.12	7.14	9.09
3	Sugarcane	N	11	2	1	14	8	1	1	10
		C	4.76	2.38	6.67	4.24	3.36	1.28	7.14	3.03
4	Spices and Condiments	N	23	5	2	30	25	8	2	35
		C	9.96	5.95	13.33	9.09	10.50	10.25	14.28	10.60
5	Curry leaves	N	8	1	1	10	35	13	1	49
		C	3.46	1.19	6.67	3.03	14.71	16.67	7.14	14.85
6	Vegetables	N	48	18	1	67	18	8	1	27
		C	20.78	21.43	6.67	20.30	7.56	10.25	7.14	8.18
7	Fruits	N	21	12	1	34	22	11	2	35
		C	9.09	14.29	6.67	10.30	9.24	14.10	14.29	10.60
8	Flowers	N	15	8	1	24	25	10	1	36
		C	6.49	9.52	6.67	7.27	10.50	12.82	7.14	10.90
9	Groundnut	N	11	1	1	13	19	5	1	25
		C	4.76	1.19	6.67	3.94	7.98	6.41	7.14	7.58
10	Coconut	N	31	5	2	38	18	6	1	25
		C	13.42	5.95	13.33	11.51	7.56	7.69	7.14	7.58
11	Cotton	N	5	1	1	7	12	5	1	18
		C	2.16	1.19	6.67	2.12	5.04	6.41	7.14	5.45
12	Medicinal Plants	N	8	8	1	17	1	0	1	2
		C	3.46	9.52	6.67	5.15	0.42	0	7.14	0.60
13	**ALL**	N	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
		C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019) N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers. Cereals- Cholam, Cumbu, Maize, Pulses- Bengal gram, Red gram, Green gram, Black gram, Horse gram, Spices and Condiments- Chilli, Coriander, Turmeric, Tamarind, Arecanut, Fruits- Mango, Guava, Grapes, Lemon, Banana, Sapota, Amla Vegetables- Tapioca, Onion, Brinjal, Lady finger, Tomato, Cauli flower, Medicinal plants- Aloe vela, Thulasi.

The cropping pattern in the Thondamuthur block reveals that vegetables (20.30 per cent), pulses (12.42 per cent), coconut (11.51 per cent), cereals (10.61per cent), fruits (10.30 per cent), spices, and condiments (9.09 per cent), flowers (7.27 per cent), medicinal plants (5.15 per cent), sugarcane (4.24 per cent) curry leaves (3.03 per cent) groundnut (3.94) and cotton (2.12 per cent) and in Annur the cropping pattern as curry leaves (14.85 per cent),

cereals (11.51 per cent), flowers (10.90 per cent) fruits and spices and condiments (10.60 per cent), pulses (9.09 per cent), vegetables (8.18 per cent), coconut and groundnut (7.58 per cent), cotton (5.45 per cent), and medicinal plants (5.15 per cent). There is a proportionate change in cropping patterns by farmers due to climate factors.

4.4. a. Details of Livestock

India's livestock sector is one of the largest in the world. About 20.5 million people depend upon livestock for their livelihood. Livestock contributed 16 per cent to the income of small farm households as against an average of 14 per cent for all rural households. Livestock provides livelihood to two-third of rural community. It also provides employment to about 8.8 per cent of the population in India. India has vast livestock resources. Livestock sector contributes 4.11 per cent GDP and 25.6 per cent of total Agriculture GDP. Economic Survey 2020 noted that livestock sector has grown at a compound annual growth rate of 7.9 per cent during last five years. As per the Economic Survey-2021, the contribution of Livestock in total agriculture and allied sector Gross Value Added (at Constant Prices) has increased from 24.32 per cent (2014-15) to 28.63 per cent (2018-19). Livestock income has become an important secondary source of income for rural families and has assumed an important role in achieving the goal of doubling farmers' income. The details of livestock production in selected study blocks are given in the table- (48).

Table-48

Details of Livestock Production in Selected Study Blocks

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Cattle	N	45	20	4	69	42	15	3	60
	C	19.48	23.81	26.67	20.90	17.64	19.23	21.43	18.18
Buffalo	N	5	3	1	9	8	3	1	12
	C	2.16	3.57	6.67	2.73	3.36	3.85	7.14	3.64
Poultry	N	123	33	6	162	49	16	4	69
	C	53.25	39.29	40.00	49.09	20.59	20.51	28.57	20.90
Sheep	N	22	12	1	35	91	26	3	120
	C	9.52	14.29	6.67	10.60	38.23	33.33	21.43	36.36
Goat	N	36	16	3	55	48	18	3	69
	C	15.58	19.04	20.00	16.67	20.17	23.08	21.42	20.90
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019), SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

In Thondamuthur block the livestock production of poultry is higher in the percentage of 49.09, where cattle rearing of 20.90 per cent, goat 16.67 per cent, sheep 10.60 percent. In Annur block sheep is higher in percentage of 36.36 where poultry and goat of 20.90 per cent respectively. The result indicated that poultry farming is higher in Thondamuthur block and sheep farming is higher in Annur block.

4.5. Problems of Farmers

Ecology problems dealing with environmental degradation consequently result in low productivity (Sharma,et.al.,2017). Attaining food security for a growing population and alleviating poverty while sustaining agricultural systems under the current scenario of depleting natural resources, negative impacts of climatic variability, spiraling cost of inputs and volatile food prices are the major challenges. The major problems faced by the farmers is given in the table- (49).

Table-49

Details of Problems Faced by the Farmers

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Size of land holdings	N	8	4	0	12	11	5	1	17
	C	3.46	4.76	0	3.63	4.62	6.41	7.14	5.15
Seeds	N	11	2	1	14	20	3	0	23
	C	4.76	2.38	6.67	4.24	8.40	3.85	0	6.97
Manures, Fertilizers and Biocides	N	20	7	1	28	28	8	1	37
	C	8.66	8.33	6.67	8.48	11.76	10.25	7.14	11.21
Lack of Mechanisation	N	45	15	1	61	32	6	1	39
	C	19.48	17.86	6.67	18.48	13.44	7.69	7.14	11.82
Soil Erosion	N	16	7	1	24	51	9	2	62
	C	6.93	8.33	6.67	7.27	21.43	11.54	14.29	18.79
Irrigation	N	11	9	3	23	31	23	4	58
	C	4.76	10.71	20	6.97	13.02	29.49	28.57	17.58
Agriculture Marketing	N	19	11	4	34	25	6	2	33
	C	8.22	13.09	26.67	10.30	10.50	7.69	14.29	10
Inadequate storage facilities	N	39	17	2	58	21	8	1	30
	C	16.88	20.24	13.33	17.58	8.82	10.26	7.14	9.09
Inadequate transport	N	29	7	1	37	8	4	1	13
	C	12.55	8.33	6.67	11.21	3.36	5.12	7.14	3.93
Scarcity of capital	N	33	5	1	39	11	6	1	18
	C	14.29	5.95	6.67	11.82	4.62	7.69	7.14	5.45
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019) N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

Most of the farmers are affected by the lack of mechanization is 18.48 per cent, inadequate storage facilities are 17.58 per cent, scarcity of capital is 11.82 per cent,

inadequate transport is 11.21 per cent, agriculture marketing is 10.30 per cent and, other factors were affected by less than 10 per cent in Thondamuthur block while in Annur block most of the farmers were affected by soil erosion of 18.79 per cent, irrigation is 17.58 per cent, lack of mechanization is 11.82 per cent and, fertilizers is 11.21 per cent where the other factors affect less than 10 per cent. The majority of the farmers were affected by the soil erosion in the Annur block and the Lack of mechanization in the Thondamuthur block.

4.5. a. Problem of Climate Change

Climate change and agriculture are interrelated processes, both of which take place on a global scale. Agriculture is particularly vulnerable to climate change. Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation. Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines (Siva raj et.al., 2017). Agriculture is sensitive to short-term changes in weather and seasonal, annual, and longer-term variations in climate.

Table- (50) reveals that majority of the selected farm households (92.73 and 93.94 per cent) perceived climate variability during the last ten years in both Thondamuthur and Annur blocks. The type of variability examined the problems faced by the farmers due to climate change, where the most of the farmers affected by monsoon failure, the percentages are being 43.33 in Thondamuthur and 47.88 in Annur blocks, where 27.77 per cent and 27.27 per cent of the farmers affected by high temperature and percentage of 25.15 and 21.51 is affected by less rain fall in which the farmers in both the blocks were affected by same climatic factors. Thus in both the blocks need local specific technological interventions to make the agriculture resilient. The impact of climate variability on crop yield was clearly perceived by the sample households of both the blocks with more than 50 per cent declined in the crop yield since last 10 years. It is to be noted that monsoon failure of more than 40 per cent decline in yield is mere observation of the farmers which needs to be scientifically validated. To mitigate the impact of climate variability, some of the farmers adopted measures such as changing cropping (48.18 per cent in Thondamuthur and 49.70 per cent in Annur) date of sowing (20.91 per cent in Thondamuthur and 20.30 per cent in Annur) and adaption of water harvesting techniques (27.58 per cent in Thondamuthur and 23.64 per cent in Annur). The adoption of above measures varies in both the blocks and there are many farmers who do nothing to adopt the changing climate condition. Thus, these farmers can be targeted to make

the agricultural practices climate resilient in the blocks using suitable technological, water management and policy interventions (Srivastava et.al., 2012).

Table- 50

Details of Problems of Climate Change

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Climate Change Observed in Last 10 years									
Yes	N	213	80	13	306	225	72	13	310
	C	92.21	95.24	86.67	92.73	94.54	92.31	92.86	93.94
No	N	18	4	2	24	8	6	1	15
	C	7.79	4.76	13.33	7.27	5.46	7.69	7.14	4.56
Type of Variability									
Drought	N	8	4	1	13	6	2	1	9
	C	3.46	4.76	6.67	3.94	2.52	2.56	7.14	2.73
Flood	N	0	1	0	1	1	0	1	2
	C	0	1.19	0	0.30	0.42	0	7.14	0.61
Less rainfall	N	58	22	3	83	51	18	2	71
	C	25.10	26.19	20.00	25.15	21.43	23.08	14.29	21.51
High Temperature	N	65	21	4	90	67	21	2	90
	C	28.13	25.00	26.67	27.27	28.15	26.92	14.29	27.27
Monsoon Failure	N	100	36	7	143	113	37	8	158
	C	43.29	42.86	46.67	43.33	47.48	47.44	57.14	47.88
Impact of Climate Variability on Crop Yield									
<10 per cent decline	N	71	25	4	100	60	24	4	88
	C	30.74	29.76	26.67	30.30	25.21	30.77	28.57	26.67
>10 per cent decline	N	108	40	7	155	132	36	8	176
	C	46.75	47.62	46.67	46.97	55.46	46.15	57.14	53.33
No decline	N	0	0	1	1	0	0	0	0
	C	0	0	6.67	0.30	0	0	0	0
Complete destruction	N	52	19	3	74	46	18	2	66
	C	22.51	22.62	20	22.42	19.33	23.08	14.27	20.00
Measures to Adopt Climate Variability									
Change in cropping pattern	N	112	40	7	159	117	38	9	164
	C	48.48	47.62	46.67	48.18	49.16	48.72	64.29	49.70
Change in water conservation	N	62	25	4	91	59	17	2	78
	C	26.84	29.76	26.67	27.58	24.79	21.79	14.28	23.64
Change in soil conservation	N	50	16	3	69	50	15	2	67
	C	21.64	19.05	20.00	20.91	21.00	19.23	14.29	20.30
Nothing	N	7	3	1	11	12	8	1	21
	C	3.03	3.57	6.67	3.33	5.04	10.26	7.14	6.36

Source: Field Survey, (2019) SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

4.5. b. Scaling Technique

Opinion of the Farmers on Impact of Climate Change on Agriculture

Global warming may also threaten food security in India if there is a negative effect on agriculture. Though there are increasing CO_2 concentrations that will increase the net primary productivity of plants, changes in climate, and the changes in disturbance regimes associated

with them, may lead either to increased or decreased net ecosystem productivity (Mall et.al., 2006).

The study revealed that the impact of climate change in agriculture production was asked to rank the various opinions regarding the performance of agriculture based on expectation and realization in their order of priority. Then the ranks were converted into per cent position from the per cent position, the individual scores is determined on a scale of 100 points by using Garrett's rating scale. The average scores and the ranks corresponding to each purpose are shown in the table- (51).

Table- 51

Details on Opinion of the Farmers on Impact of Climate Change and Agriculture in Selected Farm Households

Particulars	Thondamuthur				Annur			
	Expectation		Realization		Expectation		Realization	
	Scores	Rank	Scores	Rank	Scores	Rank	Scores	Rank
Inadequate Rainfall	71.44	2	68.29	3	78.36	2	76.29	2
High Temperature	70.56	3	69.72	2	82.03	1	69.98	3
Monsoon failure	75.23	1	72.69	1	72.56	3	79.31	1
Change in cropping pattern	69.27	4	52.36	5	67.58	5	69.20	5
Migration	15.23	9	11.03	9	9.63	9	42.03	7
Change in farm income	58.69	5	57.29	4	69.89	4	29.35	9
Unemployment	44.10	6	42.96	6	38.26	8	71.65	4
Land Sale	21.05	7	17.53	8	59.32	6	36.23	8
Other Purposes	18.69	8	26.39	7	42.16	8	62.36	6

Source: Field Survey, (2019).

The opinion of the farm households on climate change in Thondamuthur the agriculture production was ranked and discussed in this section with two criteria expectation and realization. Among the expectation criteria, the respondents were ranked 1st for monsoon failure, inadequate rainfall (2nd rank), high temperature (3rd rank), change in cropping pattern (4th rank), change in farm income (5th rank), other purposes (6th rank), unemployment (7th rank) land sale (8th rank), migration (9th rank), these are various factors expected by the farmers on climate change. Meanwhile, under the realization criteria, farmers have ranked some opinions on the impact of climate change which were listed and ranked as follows monsoon failure (1st rank), high temperature (2nd rank), inadequate rainfall (3rd rank), Change in farm income (4th rank), change in cropping pattern (5th rank), unemployment (6th rank), other purposes (7th rank), land sale (8th rank), migration (9th rank). The impact of climate change in agriculture production was unanimous on stating the same opinion under expectation and realization criteria are monsoon failure (1st rank), migration (9th rank), these

are the various factors expected and realized by the impact of climate change in Thondamuthur block.

In Annur study block on the respondents were ranked 1st for high temperature, inadequate rainfall (2nd rank), monsoon failure (3rd rank), change in farm income (4th rank), change in cropping pattern (5th rank), land sale (6th rank), unemployment (7th rank), other purposes (8th rank), migration (9th rank), these are various factors expected on the impact of climate change. Meanwhile, under the realization criteria, farmers have ranked some opinions on the impact of climate change which were listed and ranked as follows monsoon failure (1st rank), inadequate rainfall (2nd rank), high temperature (3rd rank), unemployment (4th rank), change in cropping pattern (5th rank), other purposes (6th rank), migration (7th rank), land sale (8th rank), migration (9th rank). The impact of climate change in agriculture production was unanimous on stating the same opinion under expectation and realization criteria are change in cropping pattern (5th rank) are the factors expected and realized by the impact of climate change in agriculture production in Annur block.

4.6. Concept of Crop Diversification

While uncertainty and risk to varying degrees surround all forms of activity, it is considered more of a problem for agricultural production due to the influence of climate on the agriculture output and the length of the agriculture production cycle. The different types of uncertainty while most farmers face climatic factors, pests this type of uncertainty and policies related to agricultural production marketing. In this respect, diversification is considered under the spontaneous response to avoid many of these uncertainties.

Crop diversification is an option for managing these uncertainties. The mixed cropping allows more productive and sustainable crop rotation which again favors some system diversification. Farmers are required to diversify their cropping pattern from food grains to high-value crops such as fruits and vegetables. The high-value segment of agriculture offers considerable opportunities to farmers for improvement in their livelihood as the food basket is undergoing a significant change. The consumption of food items is moving away from food grains and changing towards horticultural products like fruits and vegetables, food items of animal origin like milk, eggs, meat, fish, etc. This shift in consumption pattern to some extent resulted in diversification towards high-value food and change in income and taste and preferences of consumers Hence, there is a need to diversify the cropping pattern from traditional cereal crops to high-value crops such as fruits and vegetables.

Agricultural diversification is one of the several pathways of agricultural development. Diversification-led growth is expected to generate enormous income and

employment opportunities for the farmers, especially smallholders and rural labourers. Majority of high-value commodities especially vegetables are labour intensive. In Indian agriculture, diversification has occurred both between crops and across activities (that is, crop cultivation, livestock rising, forestry, and fishing). Within agriculture, the share of output and employment in the non-crop sectors, i.e. animal husbandry, forestry, and fisheries, has been gradually increasing. significant diversification is taking place in terms of moving away from crop production to other agriculture-allied activities. there are two kinds of diversification (Mithiya et al. 2012) at farm level: horizontal diversification and vertical diversification. Horizontal diversification refers to the cultivation/introduction of different kinds of crops that is, minor crops, fruits, and vegetables along with conventional major crops at farm level by farmers. Vertical diversification occurs when farmers engage themselves in different value-added activities at the farm level or adopt some other enterprises that is, livestock, poultry farming and fish farming along with the growth of crops at farm level. the advent of new agricultural technology particularly, water-seed-fertilizer technology, a significant change in land allocation towards some high value cash crops such as fruits and vegetables cultivated is evidenced in India, particularly by the small farmers.

Crop diversification as a concept and tool is a strategy to maximize the use of land, water, and other resources and for the overall agricultural development in the country. It provides the farmers with viable options to grow different crops on their land around the year. The diversification in agriculture is also practiced with a view to avoiding risk and uncertainty due to climatic and biological vagaries. It minimizes the adverse effects of the current system of crop specialization and monoculture for better resource use, nutrient recycling, reduction of risks and uncertainty and better soil conditions. It also provides better economic viability with value-added products and improvement of ecology.

Agricultural diversification construed in the sense of change in the cropping pattern towards high-value crops is undoubtedly a major factor contributing towards agricultural development. the small and the marginal farmers who dominate the agricultural scenario of most of the Indian states, including West Bengal, can generate higher farm income and employment and mitigate risks by adopting a diversified crop portfolio (Vyas, 1996). Based on the aforementioned discussion, it may be argued that the small and marginal farmers, depending on a small piece of land and having no alternative sources of employment and income due to the existence of a vast population of surplus labour in the countryside, would always try to produce the maximum output on the given piece of land. They would also try to

cultivate as many crops as possible and choose such high-value crops (for example, boro paddy, oilseeds like rapeseed and mustard, potato, jute, fruits and vegetables), which after meeting their consumption needs, would meet their minimum cash requirements for the maintenance of their daily life. Even the medium and large farmers approach diversification for the improvement of their living standard. Thus the phenomenon of crop diversification in India could be viewed as the survival needs of the farmers, especially of the small and marginal ones. Agricultural diversification is also contributing to employment opportunities in agriculture, increasing incomes. Agricultural diversification is strongly influenced also by price policy and income of farmers. Rural literacy also has an influence on crop diversification. It has also been observed that rain fed areas have benefited more as a result of agricultural diversification in favour of high-value crops by substituting inferior coarse cereals.

Crop diversification during the past and present crop production due to climate change was measured using the Hirschman-Herfindhal diversification index. The diversification index was calculated as D1=1-H; where H in the Hirschman-Herfindhal diversification index is measured as,

$$\mathbf{H=\sum [(CP_{ij}/\sum P_{ij})]^2}$$

P_{ji} being the value of production of the i^{th} crop for the j^{th} farmer. The higher diversity index indicates greatest crop diversity in production pattern. This is a mean to reduce risk in terms of individual farm income risk. With only one or two food crops, farm income in much riser to natural hazards than with a more diversified cropping system (Healey,1987). Timmer (1990) has identified three reasons for policy makers to pay more attention to agricultural diversification:

i) When output prices are highly unstable, a well-diversified and flexible agriculture provides more stable farm income.

ii) Diversification of rural economy is a significant source of income growth for rural people; it provides better living standards and reducing rural to urban migration.

iii) in the long run, a diversified cropping pattern is more sustainable than the intensive Cultivation of a single crop. The crop diversification index for the different crops cultivated in the selected block were calculated using the Hirschman-Herfindhal index and are shown in the following table- (52).

The crop diversification using Herfindhal Index and it had compared the indices of both past and present cropping pattern due to climate change in selected blocks. The Herfindhal Index attains significance level when the result is nearest to 1.

Table- 52

Crop Diversification Index in Selected Study Blocks

Crops	Past				Present			
	SF	MF	LF	ALL	SF	MF	LF	ALL
Thondamuthur								
Cereals	0.982	0.857	0.963	0.991	0.999	0.875	0.984	0.999*
Pulses	0.954	0.977	0.892	0.989	0.924	0.998	0.847	0.998*
Sugarcane	0.897	0.866	0.760	0.764	0.867	0.755	0.680	0.757
Spices and Condiments	0.986	0.823	0.990	0.982	0.993	0.893	0.987	0.963
Curry leaves	0.951	0.879	0.852	0.941	0.953	0.996	0.843	0.879
Vegetables	0.994	0.921	0.953	0.986	0.976	0.995	0.937	0.999*
Fruits	0.651	0.876	0.952	0.768	0.890	0.934	0.950	0.991*
Flowers	0.992	0.996	0.668	0.875	0.992	0.669	0.833	0.942
Groundnut	0.990	0.851	0.852	0.684	0.674	0.682	0.837	0.739
Coconut	0.964	0.754	0.654	0.984	0.996	0.964	0.953	0.997*
Cotton	0.684	0.964	0.741	0.874	0.950	0.983	0.854	0.730
Medicinal Plants	0.725	0.867	0.684	0.626	0.758	0.885	0.756	0.754
Annur								
Cereals	0.864	0.953	0.992	0.953	0.992	0.752	0.953	0.992*
Pulses	0.961	0.853	0.954	0.843	0.910	0.874	0.951	0.954
Sugarcane	0.834	0.853	0.854	0.684	0.776	0.945	0.853	0.854
Spices and Condiments	0.784	0.864	0.934	0.959	0.997	0.874	0.845	0.997*
Curry leaves	0.853	0.974	0.981	0.921	0.925	0.997	0.996	0.998*
Vegetables	0.941	0.682	0.932	0.992	0.968	0.854	0.850	0.885
Fruits	0.888	0.973	0.911	0.982	0.684	0.956	0.940	0.991*
Flowers	0.987	0.857	0.835	0.861	0.991	0.684	0.668	0.994*
Groundnut	0.777	0.831	0.687	0.897	0.995	0.997	0.891	0.662
Coconut	0.753	0.887	0.759	0.941	0.991	0.684	0.753	0.870
Cotton	0.954	0.915	0.954	0.973	0.611	0.781	0.953	0.754
Medicinal Plants	0.268	0.452	0.412	0.521	0.368	0.478	0.445	0.547

Source: Field Survey, (2019) N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers. Cereals- Cholam, Cumbu, Maize, Pulses- Bengal gram, Red gram, Green gram, Black gram, Horse gram, Spices and Condiments- Chilli, Coriander, Turmeric, Tamarind, Arecanut, Fruits- Mango, Guava, Grapes, Lemon, Banana, Sapota, Amla Vegetables- Tapioca, Onion, Brinjal, Lady finger, Tomato, Cauli flower, Medicinal plants- Aloe vela, Thulasi

In Thondamuthur block the diversification index calculation clearly explains that present have more diversification comparatively to past have 0.986 diversification index for vegetables wherein present have 0.999. In cereals present had 0.999 of diversification and past attained only 0.991. In the selected block, among the farm households small farmers had maximum crop diversification mainly in cereals (0.999), flowers (0.992), coconut (0.996) and

spices and condiments (0.993) respectively. In Annur block the diversification index calculation clearly explains that present have more diversification comparatively to past have 0.921 diversification index for curry leaves wherein present have 0.998. In cereals present had 0.992 of diversification and past attained only 0.953. In the selected block, among the farm households small farmers had maximum crop diversification mainly in cereals (0.992), flowers (0.991), coconut (0.995) and spices and condiments (0.997). Through this analysis we clearly demonstrate that crop diversification favour to selected small farm households.

Modified Entrophy Index

This index weights the shares of a farm's activity by a long term of the inverse of the respective shares. It takes then the value of zero when the farm is completely specialized, and it will approach its maximum when diversification is perfect. We consider eight micro level factors influencing farm diversification. The term diversification here is confined to crop production. The micro level factors are farm size (area), farmer's experience (age), net worth (wealth) of the farmer, time devoted to farming (labour input), agricultural insurance, geographical or climatic and soil characteristics of the farm (location), innovation methods (with regard to types of labour used), and adoption of new technology. To find out the extent of dispersion and concentration of different crops at a given point of time and space, Modified Entrophy Index (MEI) was calculated. This index is defined as,

$$MEI = -\sum_{I=1}^{I=n} Pi \log N (Pi)$$

Modified entrophy index take a value of 1 and at maximum specialization it attains a value of 0. Hence in the present study this index has been used to rank the different crop indices. For calculating MEI major crops grown in the selected study area were chosen. Following table – (53) gives the calculated crop diversification indices in the selected study area.

The crop diversification using Modified Entrophy Index and it had compared the indices of both present and past cropping pattern in selected blocks. The Modified Entrophy Index attains significance level when the result is nearest to 0.

Table – 53
Modified Entrophy Index in Selected Farm Households

Crops	Past				Present			
	SF	MF	LF	ALL	SF	MF	LF	ALL
Thondamuthur								
Cereals	0.008	0.006	0.015	0.024	0.007	0.005	0.008	0.002
Pulses	0.005	0.011	0.009	0.016	0.005	0.009	0.007	0.002
Sugarcane	0.009	0.021	0.016	0.021	0.006	0.007	0.008	0.012
Spices and Condiments	0.011	0.008	0.007	0.011	0.002	0.008	0.010	0.001
Curry leaves	0.006	0.007	0.012	0.040	0.001	0.009	0.008	0.010
Vegetables	0.009	0.008	0.008	0.008	0.004	0.005	0.007	0.001
Fruits	0.009	0.001	0.008	0.009	0.008	0.001	0.011	0.006
Flowers	0.010	0.021	0.007	0.013	0.007	0.008	0.009	0.008
Groundnut	0.008	0.028	0.015	0.012	0.009	0.002	0.002	0.016
Coconut	0.009	0.001	0.004	0.006	0.008	0.007	0.005	0.001
Cotton	0.017	0.008	0.009	0.016	0.007	0.004	0.006	0.012
Medicinal Plants	0.023	0.012	0.015	0.019	0.009	0.011	0.009	0.011
Annur								
Cereals	0.010	0.023	0.008	0.019	0.008	0.009	0.002	0.009
Pulses	0.002	0.004	0.009	0.009	0.010	0.005	0.007	0.004
Sugarcane	0.021	0.010	0.032	0.029	0.011	0.006	0.005	0.012
Spices and Condiments	0.011	0.009	0.022	0.013	0.009	0.007	0.009	0.003
Curry leaves	0.009	0.014	0.019	0.020	0.005	0.008	0.010	0.001
Vegetables	0.012	0.009	0.012	0.012	0.013	0.010	0.002	0.008
Fruits	0.008	0.011	0.009	0.024	0.017	0.009	0.007	0.003
Flowers	0.021	0.030	0.011	0.010	0.009	0.001	0.006	0.004
Groundnut	0.020	0.010	0.021	0.011	0.007	0.012	0.008	0.005
Coconut	0.011	0.002	0.017	0.022	0.015	0.011	0.011	0.010
Cotton	0.008	0.012	0.009	0.026	0.020	0.018	0.009	0.020
Medicinal Plants	0.023	0.032	0.012	0.032	0.015	0.021	0.019	0.021

Source: Field Survey, (2019) N is Number stated, C is column total percentage, SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers. Cereals- Cholam, Cumbu, Maize, Pulses- Bengal gram, Red gram, Green gram, Black gram, Horse gram, Spices and Condiments- Chilli, Coriander, Turmeric, Tamarind, Arecanut, Fruits- Mango, Guava, Grapes, Lemon, Banana, Sapota, Amla Vegetables- Tapioca, Onion, Brinjal, Lady finger, Tomato, Cauli flower, Medicinal plants- Aloe vela, Thulasi

The Modified Entrophy Index calculation clearly ranked that present adopters have more diversification comparatively to past. In Thondamuthur block the Present have 0.001 diversification index for vegetables ranking 1st wherein past have 0.008. The cereals and condiments present had 0.002 and 0.00 diversification ranking 2nd and past attained 0.024 and 0.014 per cent. In the Thondamuthur block, among the farm households small farmers had maximum crop diversification mainly vegetables (0.004), cereals (0.007), pulses (0.005), and fruits (0.006).The fruits had 0.006 diversification index ranking 3rd wherein past had 0.008.

In Annur block the Present have 0.001 diversification index for curry leaves ranking 1st wherein past have 0.020. The pulses and flowers present had 0.004 diversification ranking

2nd and past attained 0.023 and 0.010 per cent. In the Annur block, among the farm households small farmers had maximum crop diversification mainly curry leaves (0.005), cereals (0.008), pulses (0.010), and fruits (0.017). The fruits and spices and condiments had 0.003 diversification index ranking 3rd wherein past had 0.024 and 0.013. Through Modified Entrophy Index among the selected farm households the study found that crop diversification favors more to present adopters with special reference to small farmers. The above explanation clearly indicated that cropping pattern at present play vital role in improving farming practices.

Diversification or crop shift is a new paradigm of growth and becomes a necessity for the survival of agriculture in India (Kumar and Mittal, 2006). Diversification in agriculture refers to adoption of farming system involving shift in cropping pattern from traditionally grown less remunerative crops to more remunerative crops like oil seeds, pulses, fodder crops, horticulture, medicinal and aromatic plants, floriculture etc, and including land-based activities like livestock and fishery enterprises. Crop diversification is desirable in order to boost rural farm incomes and food security.

4.7. Technical Efficiency

The efficiency of production is extremely important for output growth: using existing resources in the best possible manner would yield the highest possible output for the given technological determinants. One important reason for low productivity in that farmers with low literacy rates and inadequate physical infrastructure face difficulties in understanding new technologies and therefore, fail to fully exploit these technical opportunities. In the light of these facts, it is clear that an increase in agricultural production can come from an increase in production efficiency. Hence, it is essential to assess how the existing inputs are being used, and what possibilities exist for improving inputs are being used, and what possibilities exist for improving efficiency of agriculture production in India, given the resource constraints. The technical efficiency of a farm/ production unit can be measured in terms of allocative efficiency (reflecting the ability of a farm to use inputs in optimal proportions, given their respective prices) and technical efficiency (TE). The results of (Shanmugam 2000, 2002 and 2003), these studies are careful for policy makers to rationalize the development policies for a particular crop in the region. However, no attempt has been made to analyse the efficiency of agriculture production as a whole at block levels. In this study, has attempted to measure the TE of agricultural production in the selected study blocks.

This study uses the stochastic frontier production function model for cross sectional data. To define the frointier production function as the maximum feasible or potential output that can be produced by a production limit such as farm, given level of inputs and technology. The actual production function (corresponding to the production units of actual output) can be written as:

$$\ln Y_i = \alpha + \beta_1 lnx_1 + \beta_2 lnx_2 + \beta_3 lnx_3 + \beta_4 lnx_4 + v_i - u_i$$

Where, is the Actual output of the i^{th} farm in quintals,

α is the constant term

X_1 is the cropped area

X_2 is the human labour in man hours

X_3 is the bullock labour in pair hours

X_4 is the fertilizers used in quantity (NPK)

βi is unknown parameter estimates

vi is the symmetric component of the error term

ui is the non-negative random variable that is under the control of the farm households.

'u' takes the value of zero when the farm households are efficient and assume the value greater than zero when the farm households are inefficient. A negative value of u varies depending on the level of inefficiency. The Maximum Likelihood Estimation (MLE) method enables us to obtain the maximum possible output function. It is assumed that u and v are independent and u follows a half-normal distribution with variance and v follows a normal distribution has estimated the frontier and firm-specific technical efficiencies.

4.7. a. Input and Output of Agriculture Crops in Selected Farm Households

The Technical efficiency of input and output details for selected crops is given in the table- (54).

Table- 54

Average Level of Input Usage and Agriculture Output

Crops	Particulars	Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Cereals	Cropped Area	1.42	2.26	3.95	1.62	1.35	2.16	3.45	1.71
	Human Labour	456	468	445	475	845	974	996	385
	Bullock Labour	112	129	119	82	123	145	153	75
	Fertilizers	25	31	39	47	26	32	39	19
	Production	17.23	25.36	23.56	7.41	21.62	31.02	22.16	10.6
Vegetables	Cropped Area	1.53	2.38	3.46	1.78	1.26	2.45	3.67	1.48
	Human Labour	1234	1496	1363	1123	445	453	469	463
	Bullock Labour	232	193	123	162	132	145	123	86
	Fertilizers	123	162	195	224	26	28	31	43
	Production	32.06	30.53	31.25	34.53	18.63	19.63	21.60	8.53
Pulses	Cropped Area	1.26	2.06	2.96	1.42	1.99	2.59	2.86	1.53
	Human Labour	742	867	738	349	468	462	334	864
	Bullock Labour	145	153	162	61	69	75	59	123
	Fertilizers	24	29	31	17	27	32	28	112
	Production	20.35	33.10	23.45	9.16	14.26	19.36	21.95	16.78
Spices and Condiments	Cropped Area	1.02	1.96	2.63	1.05	1.26	2.86	3.12	2.36
	Human Labour	235	425	321	849	1532	1511	1263	1131
	Bullock Labour	65	71	56	112	268	205	145	172
	Fertilizers	22	29	32	107	113	175	187	236
	Production	18.63	15.56	18.36	6.62	31.23	38.11	39.62	34.26

Source: Field Survey, (2019) SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers. Cereals- Cholam, Cumbu, Maize, Pulses- Bengal gram, Red gram, Green gram, Black gram, Horse gram, Spices and Condiments-Chilli, Coriander, Turmeric, Tamarind, Arecanut, Vegetables- Tapioca, Onion, Brinjal, Lady finger, Tomato, Cauli flower.

In the Thondamuthur block, the cropped area and the reference crops were positively associated with the size of landholding. Human labour use per hectare for vegetables and pulses was higher on small and medium farmers than compared to large farmers' counterparts. On the contrary, human labour use per unit area of vegetables and pulses was the highest on medium farmers. The number of fertilizers used per unit area increased with the size of holdings in all the crops. Per unit output of vegetables and pulses was the highest on medium farmers whereas small farmers obtain the highest vegetables and pulses output per unit area respectively. In Annur block the cropped area and the reference crops were also positively associated with the size of landholding. Human labour use per hectare for spices and condiments and cereals was higher on small and medium farmers than compared to large farmers' counterparts. The number of fertilizers used per unit area increased with the size of holdings in all farmer types. Per unit output of cereals and spices and condiments was the highest obtained output per unit area respectively.

Average Production Function

The average Production function estimated the average contribution of different input factors to output through the Cobb Douglas production function using the ordinary least squares technique (OLS). The OLS can be interpreted as a measure of the average performance of the sample observations evaluated at the mean input levels. The output elasticities with respect to OLS estimation results are presented in the table- (55).

Table- 55

Average Level of Input Usage and Agriculture Output in Thondamuthur Block

Particulars	Cereals	Vegetables	Pulses	Spices and Condiments
Constant	1.182 (1.821)	0.412 (1.513)*	0.504 (1.145)*	0.169 (0.512)
Cropped area	0.499 (5.697)	0.613 (6.217)	0.684 (7.843)	0.619 (4.486)
Human Labour	0.175 (0.642)	0.128 (1.242)*	0.169 (2.432)*	0.153 (1.823)
Bullock labour	0.040 (0.905)	0.098 (0.798)	0.089 (1.178)	0.041 (0.289)
Fertilizers	0.301 (5.753)*	0.029 (2.030)*	0.019 (2.784)*	0.041 (3.526)*
R^2	0.816	0.798	0.823	0.749
F	231.219	52.763	91.766	42.489

Source: Field Survey, (2019) SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers. Cereals- Cholam, Cumbu, Maize, Pulses- Bengal gram, Red gram, Green gram, Black gram, Horse gram, Spices and Condiments-Chilli, Coriander, Turmeric, Tamarind, Arecanut, Vegetables- Tapioca, Onion, Brinjal, Lady finger, Tomato, Cauli flower. Note: Figures in parentheses are t values

In the Thondamuthur block the area under the concerned crop as well as quantity of fertilizers used to tend to be a significant determinant of output. Human labour contributed significantly to vegetables and pulses output but not so much to cereals and spices and condiments. The elasticity coefficient of bullock labour is not statistically significant for the selected crops.

Table-56

Average Level of Input Usage and Agriculture Output in Annur Block

Particulars	Cereals	Vegetables	Pulses	Spices and Condiments
Constant	1.126 (1.759)*	0.389 (1.496)	0.495 (1.159)	0.154 (0.459)*
Cropped area	0.456 (5.672)	0.593 (6.021)	0.759 (7.759)	0.598 (4.369)
Human Labour	0.145 (0.612)*	0.108 (1.153)	0.159 (2.369)	0.129 (1.759)*
Bullock labour	0.029 (0.899)	0.079 (0.759)	0.075 (1.185)	0.038 (0.275)
Fertilizers	0.297 (5.743)*	0.011 (1.096)*	0.016 (2.775)*	0.039 (3.518)*
R^2	0.756	0.759	0.799	0.729
F	210.206	51.368	90.395	41.459

Source: Field Survey, (2019) SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers. Cereals- Cholam, Cumbu, Maize, Pulses- Bengal gram, Red gram, Green gram, Black gram, Horse gram, Spices and Condiments-Chilli, Coriander, Turmeric, Tamarind, Arecanut, Vegetables- Tapioca, Onion, Brinjal, Lady finger, Tomato, Cauli flower. Note: Figures in parentheses are t values

In the Annur bock the area under the concerned crop as well as quantity of fertilizers used to tend to be a significant determinant of output. Human labour contributed significantly to cereals and spices and condiments output but not so much to vegetables and pulses. The elasticity coefficient of bullock labour is also not statistically significant for the selected crops.

Technical Efficiency

Technical efficiency was estimated by fitting a Frontier production function. The study used land input, man-hours, bullock pair hours, and quantity of fertilizers empirical results, and quantity of plant nutrition for input variables in the estimation of parameters the empirical results obtained for cereals, pulses, vegetables, and spices and condiments are given in the table (57). The Maximum Likelihood Estimates (MLE) is comparable to that of OLS results. However, there are few minor changes in the magnitude of coefficients except the constant term for expected.

Table-57

Parameter Estimates of Stochastic Frontier Function

Particulars	Thondamuthur				Annur			
	Cereals	Vegetables	Pulses	Spices and Condiments	Cereals	Vegetables	Pulses	Spices and Condiments
Constant	1.821 (2.69)	0.709 (2.99)	0.312 (0.59)	0.889 (3.01)	0.698 (2.68)	1.759 (2.10)	0.796 (2.69)	0.569 (0.69)
Area	0.532 (6.99)	0.929 (7.03)	0.569 (3.01)	0.675 (8.12)	0.864 (6.95)	0.453 (5.23)	0.612 (7.56)	0.486 (2.35)
Human Labour	0.146 (0.41)	0.096 (0.89)	0.069 (0.70)	0.152 (2.02)	0.089 (0.72)	0.135 (0.38)	0.145 (1.96)	0.054 (0.62)
Bullock labour	0.054 (1.02)	0.071 (0.59)	0.191 (0.92)	0.092 (0.86)	0.062 (0.42)	0.042 (0.96)	0.082 (0.71)	0.175 (0.84)
Fertilizers	0.269 (5.42)	0.011 (1.23)	0.041 (5.12)	0.023 (2.39)	0.053 (1.69)	0.201 (4.56)	0.031 (2.89)	0.062 (5.95)
$\sigma_u/\ \sigma_{v(=\lambda)}$	1.496 (1.69)	3.692 (1.91)	4.586 (0.69)	2.043 (1.72)	3.421 (1.42)	1.232 (1.12)	2.010 (1.42)	4.321 (0.59)
$\sqrt{\sigma u^2 + \sigma v^2(\sigma)}$	0.339 (5.98)	0.256 (7.32)	0.212 (5.01)	0.391 (5.86)	0.223 (6.53)	0.263 (4.56)	0.453 (6.35)	0.263 (6.98)
σu^2	0.081	0.062	0.042	0.121	0.069	0.075	0.130	0.086
σv^2	0.034	0.002	0.001	0.026	0.008	0.029	0.032	0.001
$\sigma u^2/\sigma v^2_{(=\lambda)}$	0.689	0.929	0.942	0.801	0.895	0.678	0.753	0.959
Log-likelihood	4.296	26.997	28.637	-7.653	23.025	-4.012	8.568	29.653

Source: Field Survey, (2019) SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers. Cereals- Cholam, Cumbu, Maize, Pulses- Bengal gram, Red gram, Green gram, Black gram, Horse gram, Spices and Condiments-Chilli, Coriander, Turmeric, Tamarind, Arecanut, Vegetables- Tapioca, Onion, Brinjal, Lady finger, Tomato, Cauli flower. Note: Figures in parentheses are t values

Cereals Production

Two of the four variables used in the model have a priori signs and are statistically significant at a 1 per cent level. The use of human and bullock pair hours has a positive impact on output however the estimated coefficients were not statistically different from 0. The area under cereals and the number of fertilizers used in the production process are important factors influencing the output. The output elasticity with respect to the area for cereals was 0.53 whereas; it was 0.26 for the fertilizers. The higher value of the intercept of MLE when compared with OLS estimates and comparable values of estimated parameters provide enough credence to Hick's neutral change. The estimated value were 0.081 and 0.034 respectively. A high value of λ (0.689) indicates the presence of significant inefficiencies in the production of crops. In other words, about 69 per cent of the difference between the observed and the frontier output was mainly due to the inefficient use of resources that are under the control of the selected farm households in the Thondamuthur block.

In Annur the use of human and bullock pair hours have a positive impact on output however the estimated coefficients were not statistically different from 0. The area under cereals and the number of fertilizers used in the production process are important factors influencing the output. The output elasticity with respect to the area for cereals was 0.45 whereas; it was 0.20 for the fertilizers. The higher value of the intercept of MLE when compared with OLS estimates and comparable values of estimated parameters provide enough credence to Hick's neutral change. The estimated value and were 0.071 and 0.029 respectively. A high value of λ (0.678) indicates the presence of significant inefficiencies in the production of crops. In other words, about 68 per cent of the difference between the observed and the frontier output was mainly due to the inefficient use of resources that are under the control of the selected farm households.

Table-58

Average Level of Input Usage and Cereals Output

Technical Efficiency	Thondamuthur				Annur			
	SF	MF	LF	ALL	SF	MF	LF	ALL
Less than 50 per cent	17	11	15	15	13	18	16	14
50 to 70 per cent	19	8	10	19	22	22	7	23
70 to 90	43	24	39	26	52	32	41	24
Greater than 90 per cent	21	57	36	40	13	28	36	39
Mean	0.72	0.84	0.86	0.83	0.76	0.80	0.85	0.84

Source: Field Survey, (2019), SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

The table- (58) shows the frequency distribution of estimated technical efficiency for the selected blocks. The average level of Technical efficiency noted at 83 per cent represents that the output can be raised by following efficient crop management practices without compelling to intensification the close of application of inputs. It remains perceived that about 15 per cent of the farm households have harvested lesser than 50 per cent of the frontier production were slight other than one-third was 40 per cent is probable as more than 90 per cent of the frontier output. It persisted similarly perceived that majority of the farm households (26 per cent) operated at an efficiency level between 70 and 90 per cent. Mean technical efficiency range from 0.72 on small farmers to 0.84 medium farmers and 0.86 on large farmers in the Thondamuthur block.

In Annur block average level of Technical efficiency is valued at 84 per cent shows that the yield can be higher by the following effective crop management practices deprived of having to raise the level of application of inputs. The study found that about 16 per cent of the selected farm households have harvested slighter than 50 per cent of the Frontier

production were slightly higher than one-third was 39 per cent of farm households realized more than 90 per cent of the frontier output. Generally, the farm households (24 per cent) operated at an efficiency level between 70 and 90 per cent. Mean technical efficiency range from 0.76 on small farmers to 0.80 medium farmers and 0.85 on large farm households.

Vegetables Production

All the variables used in the model have a Priori sign. The intercept value for the stochastic frontier estimated through the maximum likelihood procedure is higher than the single predictable by OLS technique towards Hick's neutral technical change. The land elasticity value is relatively high when compared to any other input elasticity and is statistically significant at a 1per cent level. The input variable turns out to be statistically insignificant. The sum of the regression coefficient is 1.07 resulting in constant returns to scale. The estimated value is higher than the estimated value. The higher magnitude indicated that the difference between the realized output and the frontier output was more due to inefficient use of resources at the discarding of the farm households. The ratio of the difference of the selected farm household's specific technical efficiency to the total variance of output (λ) indicated that 92 per cent of the variance among the observed and the frontier output is mostly due to issues that remained under the control of the selected farm households in Thondamuthur block.

In Annur the all the variables used in the model also have a Priori sign. The intercept value for the stochastic frontier estimated through the maximum likelihood procedure is higher than the one estimated by the OLS method towards the neutral technical change of hicks. The land elasticity value is relative also higher were related to any other input elasticity and is statistically significant at a 1 per cent level. The input variable turns out to be statistically insignificant. The sum of the regression coefficient is 1.06 indicates constant returns to scale. The estimated value is higher than the estimated level. The higher magnitude notes that the difference between the realized output and the frontier output was more due to inefficient use of resources at the disposal of the farm households. The ratio of the difference from the farm households under specific technical efficiency to the total variance of output (λ) showed that 89 per cent of the difference between the observed and the frontier output is mainly due to factors under the control of the selected farm households.

Table-59

Average Level of Input Usage and Vegetables Output

Technical Efficiency	Thondamuthur				Annur			
	SF	MF	LF	ALL	SF	MF	LF	ALL
Less than 50 per cent	8	22	13	17	2	11	27	15
50 to 70 per cent	37	17	7	19	28	30	15	20
70 to 90	20	37	52	28	40	24	32	32
Greater than 90 per cent	35	24	30	36	30	35	27	33
Mean	0.83	0.85	0.80	0.82	0.82	0.84	0.78	0.83

Source: Field Survey, (2019), SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

The table – (59) shows the estimated technical efficiency ranged between 0.83 on small farmers and 0.85 on medium farmers have a mean technical efficiency of 0.82 for all the farmers. The results indicated that the selected farm households realized only 82 per cent of potential output. It has illustrated that 36 per cent of the farmers were operating close to the frontier (Technical efficiency greater than 0.09). On the contrary, little more than 17 farm households realized less than 50 per cent of the potential output due to inefficient use of resources. The proportion of farmers realizing more than 90 per cent of the potential vegetable output ranged from 35per cent of the small farmers, 24 per cent of the medium farmers, and 27 per cent of large farmers in selected farm households in the Thondamuthur block.

Annur block shows the estimated technical efficiency ranged between 0.82 on small farmers and 0.84 on medium farmers under a mean technical efficiency of 0.83 of all the farmers. The results indicated that the selected farm households realized only 83 per cent of potential output. It was to note that about 33 per cent of the farmers were operating close to the frontier (Technical efficiency greater than 0.09). On the contrary, little more than 15 farm households realized less than 50 per cent of the potential output due to inefficient use of resources. The proportion of farmers realizing more than 90 per cent of the potential vegetable output ranged 30 per cent of the small farmers, 35 per cent of the medium farmers, and 27 per cent of large farmers in selected farm households.

Pulses Production

The area under pulses, hours of human labour, bullock hours, the quantity of fertilizers in Kgs as input variables is estimated. The estimated elasticity coefficients for the area under the pulses and fertilizer are statistically significant at 1 per cent. The elasticity coefficient for human labour use was statistically significant at a 2 per cent level. The estimated value and were 0.121 and 0.026, respectively.

A high value of λ (0.801) the percentage of variation in the farm-specific Technical efficiency to the total change of production indicated that nearly 80 per cent of the variance of the perceived frontier production is generally due to the ineffective use of resources which are lower than the mechanism of the selected farm households in Thondamuthur block.

The area under pulses, hours of human labour, bullock hours, quantities of fertilizers in Kgs as input variables is estimated. The estimated elasticity coefficients for the area under the pulses and fertilizer are statistically significant at 1 per cent. The elasticity coefficient for human labour use was statistically significant at a 5 per cent level. The estimated value and were 0.086 and 0.001, respectively. The higher value of λ (0.959), the ratio of the change of farm-specific Technical efficiency to the total variance of output shows that about 95 per cent of the variance between the perceived and the frontier output was mainly due to inefficient use of resources which are under the control of the selected farm households in Annur block.

Table-60

Average Level of Input Usage and Pulses Output

Technical Efficiency	Thondamuthur				Annur			
	SF	MF	LF	ALL	SF	MF	LF	ALL
Less than 50 per cent	25	21	18	24	21	32	19	23
50 to 70 per cent	14	12	32	18	8	21	34	19
70 to 90	49	41	24	36	49	26	22	35
Greater than 90 per cent	14	26	26	22	22	21	25	24
Mean	0.80	0.79	0.75	0.81	0.81	0.82	0.86	0.80

Source: Field Survey, (2019), SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

The table- (60) shows the frequency distribution of estimated technical efficiency for the selected blocks. The average level of Technical efficiency noted at 83 per cent represents that the output can be raised by following efficient crop management practices without compelling to intensification the close of application of inputs. It remains perceived that about 15 per cent of the farm households have harvested lesser than 50 per cent of the frontier production were slight other than one-third was 40 per cent is probable as more than 90 per cent of the frontier output. It persisted similarly perceived that majority of the farm households (26 per cent) operated at an efficiency level between 70 and 90 per cent. Mean technical efficiency range from 0.72 on small farmers to 0.84 medium farmers and 0.86 on large farmers in the Thondamuthur block.

In Annur block average level of Technical efficiency is valued at 84 per cent shows that the yield can be higher by the following effective crop management practices deprived of having to raise the level of application of inputs. The study found that about 16 per cent of

the selected farm households have harvested slighter than 50 per cent of the Frontier production were slightly higher than one-third was 39 per cent of farm households realized more than 90 per cent of the frontier output. Generally, the farm households (24 per cent) operated at an efficiency level between 70 and 90 per cent. Mean technical efficiency range from 0.76 on small farmers to 0.80 medium farmers and 0.85 on large farm households.

Spices and Condiments Production

The area under spices and condiments crop, human labour, bullock pair hours and fertilizers are used as input variable in the stochastic production function. Two of the four variables, namely area and fertilizers are found to influence the output. The function indicated decreasing returns to scale (sum of the coefficients is 0.59. The ratio of the variance of the farm specific TE(σ_U^2) to the total variance (σ^2)of output shows the as much 94 per cent of the difference between the observed and potential frontier output is due to inefficient use of resources which are at the disposal of the farm households in Thondamuthur block.

The area under spices and condiments crop, human labour, bullock pair hours and fertilizers are used as input variable in the stochastic production function. Two of the four variables, namely area and fertilizers are found to influence the output. The function indicated decreasing returns to scale (sum of the coefficients is 0.69. The ratio of the variance of the farm specific TE(σ_U^2) to the total variance (σ^2)of output shows the as much 95per cent of the difference between the observed and potential frontier output is due to inefficient use of resources which are at the disposal of the farm households in Annur block.

Table- 61

Average Level of Input Usage and Spices and Condiments Output

Technical Efficiency	Thondamuthur				Annur			
	SF	MF	LF	ALL	SF	MF	LF	ALL
Less than 50 per cent	24	20	17	22	21	33	18	22
50 to 70 per cent	13	13	31	18	7	21	32	18
70 to 90	48	42	23	35	48	25	22	32
Greater than 90 per cent	15	25	26	24	25	21	25	23
Mean	0.81	0.78	0.76	0.80	0.82	0.81	0.85	0.86

Source: Field Survey, (2019), SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

Mean of technical efficiency in Thondamuthur block reveals from 81 per cent for small farmers to 78 per cent on medium farmers and 76 per cent to large farmers. It is interesting to note that 24 per cent of the farmers are operating near the frontier or harvesting 90 per cent or more of the potential spices and condiments output as against 22 per cent of the farmers realized only 50 per cent of the potential output, Thus there is a scope to bridge the

gap between the actual realized and the potential output with the given technology by using available resources more efficiency.

Mean of technical efficiency in Annur block reveals from 82 per cent for small farmers to 81 per cent on medium farmers and 85 per cent to large farmers. It is interesting to note that 23 per cent of the farmers are operating near the frontier or harvesting 90 per cent or more of the potential spices and condiments output as against 22 per cent of the farmers realized only 50 per cent of the potential output, Thus there is a scope to bridge the gap between the actual realized and the potential output with the given technology by using available resources more efficiency.

4.7. b. Determinants of Technical Efficiency

An attempt was made to identify the socio-economic factors influencing the technical efficiency at the firm level. Maximum Livelihood Estimate (MLE) of technical efficiency were regressed on value of cropped area, agriculture labours, cultivators where the education is used dummy for the selected farm households with education above primary level and farm size. As the technical efficiency variable varies between 0 and 1, the variable was transformed into ln[TE/1-TE], so that the latter transformed variable now where varies between $-\infty$ and $+\infty$ which facilitates the estimation of the parameters by using the OLS technique. The following linear regression model was used to identify the socio-economic factors that condition technical efficiencies of sample households

$$\boldsymbol{Ln[TE_{ij}/1\text{-}TE_{ij}] = \alpha + \beta_1 X_{1ij} + \beta_2 X_{2ij} + \beta_3 X_{3ij} + \beta_4 X_{4ij} + \beta_5 X_{5ij} + \mu}$$

Where

TE_{ij} is the Technical efficiency for i^{th} crop on j^{th} farm households

α is the constant intercept

β_i is the regression coefficients

X_1 is the value of cropped area

X_2 is the agriculture labours

X_3 is the cultivators

X_4 is the dummy variable for education above primary level

X_5 is the size of farm households

μ is the error term

Crop output is conditioned by the distribution of rain fall incidence of diseases and pests, soil and numerous socio economic factors. A simple linear regression was used to identify the technical efficiency of farm households.

Table-62

Socio-economic Determinants of Technical Efficiency

Variables	Thondamuthur				Annur			
	Cereals	Vegetables	Pulses	Spices and Condiments	Cereals	Vegetables	Pulses	Spices and Condiments
Intercept	87.723	31.745	85.234	80.295	86.659	32.864	86.486	81.369
Land	0.002 (1.896)	0.005 (2.998)	0.001 (1.598)	0.005 (3.012)	0.003 (1.962)	0.004 (3.010)	0.002 (1.625)	0.004 (3.102)
Agriculture Labours	1.9706 (2.301)	3.0504 (1.012)	-5.6231 (3.066)	1.6987 (0.276)	1.8962 (2.123)	-2.9641 (1.238)	5.2480 (2.996)	1.569 (0.229)
Cultivators	0.3871 (0.398)	3.1252 (1.684)	0.3423 (0.139)	-14.926 (2.162)	0.3911 (0.386)	3.2134 (1.756)	0.3541 (0.142)	-15.123 (2.201)
Education	1.0012 (2.499)	3.4732 (2.398)	2.8879 (3.689)	2.929 (1.027)	1.1086 (2.369)	3.2979 (2.268)	2.8789 (3.598)	2.7861 (1.013)
Farm size	0.2135 (1.558)	-0.1259 (0.268)	-0.2653 (0.998)	-0.359 (0.378)	-0.1964 (1.456)	1.2395 (0.968)	-0.2845 (0.112)	-0.356 (0.369)
R^2	0.652	0.856	0.789	0.695	0.754	0.710	0.659	0.769

Source: Field Survey, (2019), SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.
Note: Figures in parentheses are t values

The model explained the variation in technical efficiency on the sample farm households in terms of R^2 ranging from 85 per cent for vegetables to 78 per cent in the case of pulses. As expected, some of the variables have a priori signs for all the crops. The value of land per hectare of gross cropped area was positively related with the technical efficiency and coefficient was statistical significant for most of the crops in Thondamuthur block. In Annur block the variation in technical efficiency on the sample farm households in terms of R^2 ranging from 76 per cent for spices and condiments to 75 per cent in the case of cereals. As expected, some of the variables have a priori signs for all the crops. The value of land per hectare of gross cropped area was also positively related with the technical efficiency and coefficient was statistical significant for most of the crops. In both the blocks it can be inferred that technical efficiency was influenced by the quality of land value was assumed to reflect the land and soil quality. Similarly, presence of education by the head of the family adds to the efficiency in crop production. Education helps not only in better crop management decisions, but also facilitates access to information from different sources (Tilak, 1993).The contribution of agriculture labour force to technical efficiency was positive and significant in case of vegetables and pulses in Thondamuthur block while cereals and spices and condiments in Annur block. Completion of form operations during the specific time period are very crucial, however, it becomes increasingly difficult to complete some of the critical farm operations within time as farm size increases. The delay in timely application

of inputs and completion of farm operations during critical periods on large farmers might influence efficiency negative.

The study estimated form specific technical efficiency for cereals, vegetables, pulses and spices and condiments using stochastic frontier production function approach and further attempts to identify the determinants of Technical efficiency. The analysis of the technical efficiency is indicated that there is a considerable scope to improve the productivity of levels of selected with the existing level of input use and the available technology. The inefficiency is estimated here, is in relation to the 'best peer' who also operates under similar environment and not with any standard norm (Bhende and Kalirajan (2007). Land is represented in terms of value and presence of the educated head of the family influences the level of efficiency whereas increase in the farm size tends to reduce the efficiency level. One policy implication from the study is that strengthening of extension and educating the farmers may improve the efficiency of the farmer which would lead to increased productivity and augment agricultural production.

4.8. Agriculture Loan/ Agriculture Credit System

Financing is an important driver for the growth of the agriculture sector. The timely availability of money at reasonable interest rates, especially for smallholders, is critical for inclusive and sustainable agricultural growth. The smallholders faces the risk of lack the financial resources to improve land or purchase from insurance and have limited access to formal credit (Singh, 2014). The policy interventions have led to doubling of Agricultural credit but the limited access of small and marginal farmers to institutional credit constitutes to be a matter of concern.

Table-63

Details of Agriculture Loan/ Agriculture Credit System

Particulars		Thondamuthur				Annur			
		SF	**MF**	**LF**	**ALL**	**SF**	**MF**	**LF**	**ALL**
Land lords	N	18	8	1	27	14	9	1	24
	C	7.79	9.52	6.67	8.18	0.58	11.54	7.14	7.27
Government bank	N	38	11	3	52	39	14	3	56
	C	16.45	13.09	20.00	15.76	16.39	17.95	21.43	16.97
Private bank	N	30	15	3	48	28	11	2	41
	C	12.99	17.86	20.00	14.54	11.76	14.10	14.29	12.42
Co- operative bank	N	58	21	3	82	67	16	3	86
	C	25.10	25.00	20.00	24.85	28.15	20.51	21.43	26.06
Commercial bank	N	21	9	2	32	25	9	2	36
	C	9.09	10.71	13.33	9.70	10.50	11.54	14.29	10.91
Canara bank	N	38	11	2	51	42	12	2	56
	C	16.45	13.09	13.33	15.45	17.65	15.38	14.28	16.97
NABARD	N	28	9	1	38	23	7	1	31
	C	12.12	10.71	6.67	11.52	9.66	8.97	7.14	9.39
All	**N**	231	84	15	330	238	78	14	330
	C	100	100	100	100	100	100	100	100

Source: Field Survey, (2019), SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

The agriculture loan is available to the farmers to overcome with their financial problems. Majority of farm households get loan from cooperative bank 24.85 per cent in Thondamuthur block and 26.06 per cent in Annur block next to government bank with 15.39 per cent in Thondamuthur block and 16.97 per cent in Annur block. Mostly the farmers getting loan from cooperative bank and government bank because of lesser rate of interest.

4.9. Details of ICTs

Agricultural practices and advancements differ globally since plants have their own differences and the location plays a role on their development as well. Information and Communication Technology (ICT) is used as an overarching term incorporating all modes of transmission like electronic devices, networks, mobiles, services and applications which help to disseminate information with the help of technology. In the recent years, ICT has proved to be extremely beneficial for farmers including small land holders, marginalized and poor farmers, and helped them in marketing, precision farming and improved profits (Indian council of Food and Agriculture, 2017). The details of type of ICTs usage in selected farm households was given in the table- (64).

Table-64

Details of ICTs

Particulars		Thondamuthur				Annur			
		SF	**MF**	**LF**	**ALL**	**SF**	**MF**	**LF**	**ALL**
Television	N	41	19	2	62	35	13	2	50
	C	17.75	22.62	13.33	18.79	14.71	16.67	14.29	15.15
Mobile Phone	N	133	31	9	173	149	41	9	199
	C	57.58	36.90	60.00	52.42	62.60	52.56	64.29	60.30
Radio	N	35	22	1	58	32	12	1	45
	C	15.15	26.19	6.67	17.58	13.44	15.38	7.14	13.64
Computer	N	22	12	3	37	22	12	2	36
	C	9.52	12.00	20.00	11.21	9.24	15.38	14.29	10.91
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Details of Usage of ICTs									
Less than One year	N	31	13	2	46	35	11	2	48
	C	13.42	15.48	13.33	13.94	14.71	14.10	14.29	14.54
2-3 years	N	69	23	3	95	62	21	5	88
	C	29.87	27.38	20	28.79	26.05	26.92	35.71	26.67
3-5 years	N	79	29	5	113	82	32	5	119
	C	34.19	34.52	33.33	34.24	34.45	41.03	35.71	36.06
5 and above	N	52	19	5	76	59	14	2	75
	C	22.51	22.62	33.33	23.03	24.79	17.95	14.29	22.73
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019), SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

The ICTs is most effective delivery mechanism has higher impact provided an important role in selected farm households. The details of ICTs tools provides to the farmers in selected farm house holds where usage of mobile phone is higher in both the blocks as 52.42 per cent and 60.30 per cent respectively where the mobile phone user higher proportion of farmers. The years of usage of ICTs has highly used from 3-5 years while compared to other years in both Thondamuthur and Annur blocks.

4.9. a. Details of Use of ICTs

Information and communication technologies play a crucial role in disseminating information to farmers enabling them to decide on the cropping pattern, use of high-yielding seeds, fertilizer application, pest management, marketing, etc. Traditionally, Indian farmers have been following indigenous production methods and rely upon friends, relatives, fellow farmers and input dealers to get information regarding agriculture (Indian council of Food

and Agriculture, 2017). And, ICT has now become a reliable instrument for improving the quantity and quality of the agricultural production.

Table-65

Details of Use of ICTs

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Weather forecasting	N	37	11	2	50	26	11	1	38
	C	16.02	13.10	13.33	15.15	10.92	14.10	7.14	11.52
Regional language	N	25	13	3	41	28	9	2	39
	C	10.82	15.48	20.00	12.42	11.76	11.54	14.29	11.82
Free cost	N	23	15	2	40	35	12	3	50
	C	9.96	17.86	13.33	12.12	14.71	15.38	21.43	15.15
Timely advice	N	46	16	3	65	43	11	2	56
	C	19.91	19.05	20.00	19.70	18.07	14.10	14.29	16.97
Market information	N	44	19	3	66	59	14	3	76
	C	19.05	22.62	20.00	20.00	24.79	17.95	21.43	23.03
Easy access	N	56	10	2	68	47	21	3	71
	C	24.24	11.90	13.33	20.61	19.75	26.92	21.43	21.52
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019), SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

Table- (65) explains the benefits of usage of ICTs in selected farm households where the majority of the farmers benefited by getting the information of market as 20 per cent in Thondamuthur and 23.03 per cent in Annur block next to easy access as 20.61 per cent and 21.52 per cent in both the blocks. The analysis reveals that getting information and easy access is higher benefits when compiled to other benefits.

4.9. b. Benefits of ICTs

ICTs services provide critical access to the knowledge, information and technology that farmers require to improve the productivity and thus improve the quality of their lives and livelihoods. ICTs in agriculture is also known as e- agriculture (Nandeesha, 2016). The capability of farmers to manage weather risks, technological risks, price risks and many more such risks. ICTs not only help to disseminate information, rather it also improves the farmer's knowledge base, increase their participation and share the knowledge amongst farmers. The proper use of ICTs helps to overcome the time, space, language and illiteracy barriers effectively. Thus ICTs has emerged as a core driver of the modern knowledge based economy promoting socio-economic development in selected farm households.

Table- 66

Details of Benefits of ICTs

Particulars		Thondamuthur				Annur			
		SF	MF	LF	ALL	SF	MF	LF	ALL
Weather forecasting	N	14	9	3	26	12	6	2	20
	C	6.06	10.71	20.00	7.88	5.04	7.69	14.29	6.06
Regional language	N	16	6	2	24	15	8	1	24
	C	6.93	7.14	13.33	7.27	6.30	10.26	7.14	7.27
Free cost	N	21	5	1	27	9	5	1	15
	C	9.09	5.95	6.67	8.18	3.78	6.41	7.14	4.54
Timely advice	N	16	6	1	23	20	12	1	33
	C	6.93	7.14	6.67	6.97	8.40	15.38	7.14	10.00
Market information	N	23	9	1	33	16	5	1	22
	C	9.96	10.71	6.67	10.00	6.72	6.41	7.14	6.67
Easy access	N	26	9	1	36	36	8	1	45
	C	11.25	10.71	6.67	10.91	15.12	10.26	7.14	13.64
Pricing control	N	17	12	1	30	25	4	1	30
	C	7.36	14.29	6.67	9.09	10.50	5.12	7.14	9.09
Warning alerts	N	19	4	1	24	19	7	1	27
	C	8.22	4.76	6.67	7.27	7.98	8.97	7.14	8.18
Production control	N	18	6	1	25	10	3	1	14
	C	7.79	7.14	6.67	7.58	4.20	3.85	7.14	4.24
Knowledge database	N	27	4	1	32	42	9	2	53
	C	11.69	4.76	6.67	9.70	17.65	11.54	14.29	16.06
Distribution Management	N	13	6	1	20	20	5	1	26
	C	5.63	7.14	6.67	6.06	8.40	6.41	7.14	7.88
Market Access Improvement	N	21	8	1	30	14	6	1	21
	C	9.09	9.52	6.67	9.09	5.88	7.69	7.14	6.36
All	**N**	**231**	**84**	**15**	**330**	**238**	**78**	**14**	**330**
	C	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field Survey, (2019), SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

The farmers are mostly benefited while using e-agriculture method in cultivation. The e-agriculture farmers are highly benefited in up to date information in weather forecasting and timely advice and market information has increase in agriculture production has resulted in increasing the standard of living of farmers. Table – (66) explains the benefits of ICTs by selected farmers, majority of the farmers are benefited by Weather forecasting and regional language is being 22 per cent and 20 per cent respectively, per centage of the farmers in ICTs benefits in timely advice by 18 per cent.

4.9. c. Scaling Technique

Opinion of the users about the performance of ICTs

Most farmers by their nature will possess resistance to foreseeing for future. Mostly, the negative things about framers are day-dreaming for their future by being negligent, wasting resources unnecessarily without any thought for recycling of water resource, resistance to implement new ideas and technology etc. This resistance can be overcome positively by systematically following an optimistic approach. The excellent outcomes resulting from ICTs usage in agriculture shall be exhibited and farmers shall be encouraged to use more and more of ICTs. The success of ICTs in agriculture is very much possible and can be achieved by implementing it in the present situations carefully and thoughtfully.

In the present study, the users of the ICTs were asked to rank the various opinions regarding the performance of ICTs on the basis of expectation and realization in their order of priority. The ranks were then converted into per cent position and from the per cent position the individual scores were determined on a scale of 100 points by using Garrett's rating scale. The average scores and the ranks corresponding to each purpose are shown in table-(67).

Table- 67

Details on Opinion of the User among the Performance of ICTs in Selected Farm Households

Particulars	Thondamuthur				Annur			
	Expectation		Realization		Expectation		Realization	
	Scores	Rank	Scores	Rank	Scores	Rank	Scores	Rank
Regional language	69.6	3	66.4	2	26.8	9	62.1	2
Weather forecasting	72.3	1	59.2	3	51.3	3	56.3	3
Free cost	58.5	6	44.6	5	31.0	7	54.8	4
Market Access Improvement	64.7	5	26.3	9	26.1	10	23.5	12
Market information	57.4	7	32.1	7	87.5	1	34.7	6
Easy access	65.3	4	71.3	1	38.2	6	77.3	1
Pricing control	31.9	12	39.7	6	25.3	11	23.9	11
Warning alerts	39.1	9	21.5	11	23.6	12	24.2	10
Production control	53.8	8	21.1	12	66.2	2	32.4	8
Knowledge database	36.1	10	31.8	8	42.9	5	36.5	5
Distribution Management	35.2	11	25.6	10	29.8	8	29.6	9
Timely advice	69.9	2	45.6	4	46.9	4	33.1	7

Source: Field Survey, (2019), SF- Small Farmers, MF-Marginal Farmers, LF Large Farmers.

The opinion of the climate change in Thondamuthur on the impact in agriculture production were ranked and discussed in this section with two criteria expectation and realization. Among the expectation criteria, the respondents were ranked 1st for monsoon

failure, inadequate rainfall (2nd rank), high temperature (3rd rank), change in cropping pattern (4th rank), change in farm income (5th rank), other purposes (6th rank), unemployment (7th rank) land sale (8th rank), migration (9th rank), these are various factors expected by the farmers on climate change. Meanwhile under the realization criteria farmers have ranked some opinion on the impact of climate change which were listed and ranked as follows monsoon failure (1st rank), high temperature (2nd rank), inadequate rainfall (3rd rank), change in farm income (4th rank), change in cropping pattern (5th rank), unemployment (6th rank), other purposes (7th rank), land sale (8th rank), migration (9th rank). The impact of climate change in agriculture production were unanimous on stating the same opinion under expectation and realization criteria is monsoon failure (1st rank), migration (9th rank), these are the various factors expected and realized by the impact of climate change in Thondamuthur block.

The opinion of the farmers in Annur on the impact of climate change in agriculture production were ranked and discussed in this section with two criteria expectation and realization. Among the expectation criteria, the respondents were ranked 1st for high temperature, inadequate rainfall (2nd rank), monsoon failure (3rd rank), change in farm income (4th rank), change in cropping pattern (5th rank), land sale (6th rank), other purposes unemployment (7th rank), distribution management (8th rank), migration (9th rank), these are various factors expected on the impact of climate change. Meanwhile under the realization criteria farmers have ranked some opinion on the impact of climate change which were listed and ranked as follows monsoon failure (1st rank), inadequate rainfall (2nd rank), high temperature (3rd rank), change in farm income (4th rank), change in cropping pattern (5th rank), unemployment (6th rank), land sale (7th rank), other purposes (8th rank), migration (9th rank). The impact of climate change in agriculture production were unanimous on stating the same opinion under expectation and realization criteria is change in farm income (4th rank), change in cropping pattern (5th rank), other purposes (8th rank), migration (9th rank) these are the various factors expected and realized by the impact of climate change in agriculture production in Annur block.

4.9. d. Correlation Analysis of Socio- economic Profile and ICTs Tools

The social participation extensions participation and mass media exposure have a significant relationship with the farmers same beef things will expose farmers two different sources of information where farmers start learning about the ICT Tools and techniques

farmers who have invested more on the purchase of agricultural implements TV, Radio mobile phones, others sources were used to communicate the input and machineries will efficiently utilize them in the field regularly which necessity them to know or ask your more about the ICT tools participation in different extension programs can expose them to ICT tools used by extensions personal for communications which will lead to higher level of knowledge among promised advent of mass media provides enormous opportunities for reported exposure of farmers to new technology and motivating them to action for the few of the ICT tools are part of the mass media used by the farmers a farmer who has more mass media exposed becomes innovative development risk taking ability motivation and my aspiration and will try to know more about the existing things and ask your more knowledge on ICT tools it is believed that the more farmers visit nearest city of the more will be exposure to ICT tools and also they can get knowledge from the reference input dealers and officials say about ICT tools. The relationship between socio-economic profile and ICTs tools is depicted in table- (68).

Table-68

Correlation Analysis of Socio Economic Profile and ICTs Tools

Particulars	Correlation Coefficients	
	Thondamuthur	Annur
Age	0.015^{NS}	0.013^{NS}
Education	0.365*	0.245*
Land	0.075^{NS}	0.073^{NS}
Family	0.058^{NS}	0.052^{NS}
Occupation	0.42^{NS}	0.51^{NS}
Annual income	0.342*	0.351*
Extension participation	0.329**	0.323**
ICTs tools	0.235**	0.234**
Risk orientation	0.095^{NS}	0.092^{NS}
Economic motivation	0.069^{NS}	0.065^{NS}
Innovation	0.007^{NS}	0.005^{NS}

Source: Field Survey, (2019).

In both the blocks could be observed from the table- (68) that the variables such as extension participation and ICTs had positive and significant relationship with the farmers at one per cent of significance whereas, education and income has positive and significant relationship with knowledge of farmers at 5 per cent level of significance.

4.10. Factor Analysis of Impact of Climate Change and Agriculture Production

Factor analysis has used to examine the structural relationship among the variables impact of climate change and agriculture production of the farm households. To determine

the appropriateness of applying the factor analysis, the KMO and Bartlett's test measures were computed and the results are presented in the table- (69).

Table- 69
KMO and Bartlett's Test Measures

KMO and Bartlett's Test	
Kaiser- Mayer-Olkin measures of sampling adequacy	.712
Bartlett's test of Sphericity Approx. Chi-square	389.604
Degrees of freedom	72
Significance level	.000

Source: Field Survey, (2019).

KMO statistics is 0.712 is signifying higher than acceptable adequacy of sampling. Bartlett's test of Sphericity has also found to be a significant one per cent level providing evidence of the presence of a relationship between the variables to apply factor analysis. The communalities for each variable were assessed to determine the amount of variance accounted for by the variable to be included in the factor rotations. All the variables had a value greater than 0.50 signifying substantial portions of the variance accounted by the factors. Table – (70) enlists the Eigenvalues, their relative explanatory powers, and factor loadings for 11 linear components identified with the data set.

Table-70

Rotated Component Matrix

Factors	**Components**		
	1	**2**	**3**
Monsoon Failure	.808		
Drought			.823
Low rainfall		.823	
High temperature		.890	
Less yield	.917		
Less production			.980
Low quality	.866		
Low quantity		.822	
Crop disease			.905
Soil erosion	.901		
Lack of water resources		.811	
Eigen values	4.707	1.509	1.051
Percentage of variance	32.305	16.770	11.677
Cumulative per centage	32.305	69.075	80.752

Source: Field survey, (2019), Extraction Method: Principal Component Analysis., Rotation Method: Varimax with Kaiser Normalization, Rotation converged in 3 iterations

Factor 1 has significant loadings for four dimensions nearly monsoon failure, less yield, low quality, soil erosion. These dimensions explained 32 per cent of the variance. Factor 2 has significant loadings for four dimensions nearly, low rainfall, high temperature, low quantity, lack of water resources has explains 16 per cent of the variance. Factor 3 has significant loading on three dimensions namely drought, less production, crop disease explains nearly 11 per cent of the variance. Hence these are the various factors assessing the impact of climate change.

Certain limitations of this study

The major issue here is that the firm efficiency concept has been applied to district (blocks) level data, and that data use of aggregated across selected crops.

This study results can be interpreted as inductive aggregative efficiency measures of selected farms within the concerned blocks.