CHAPTER- III

METHODOLOGY

A systematic and careful analysis of information is of primary important in any research in order to obtain reliable results, it is essential to evolve scientific methods of data collection and employ appropriate and reliable techniques for the analysis information. The methodology adopted in the current study on is presented and discussed under following heads.

3.1. Selection of the Problem

Climate change affects remain to be capable throughout whole regions and also at the world level (World Meteorological report, 2017). “Sustained radiation of greenhouse gases would originate extra heating and long-lasting differences in all components of the earth’s atmosphere, accumulating the probability of un-assumed, predominant, and irreversible effects on societies and environments”. Climate-related hazards distress poor people’s remains directly through belongings on livelihoods and failures in crop yields (Intergovernmental Panel on Climate Change, IPCC 2018). India has been ordered as the sixth climate change vulnerable nation in the territory in terms of facing exciting climate actions. Global warming is assessed to require extensive and penetrating influences on

situations affecting agriculture, including temperature, carbon dioxide, glacial runoff, precipitation, and the collabouration of these components. The effect of climate change on agriculture-related conservational difficulties is among the foremost progressive concerns in India nowadays.

Agriculture is depends on climate and weather events. There is change in temperature and rainfall patterns, which may be increase or decrease in their patterns. These impacts would affect the farmers because of excessive dependence on rainfall and higher temperature and inadequate adaptive capacity of farmers (Mahato, 2014). IPCC, 2018 predicted that there is 10 to 25 per cent of decline in productivity of agriculture by 2080^{s} and also faced by crop failure in some regions of developing countries due to higher temperature, unavailability of infrastructure like farm loan, irrigation, insurance for farming activities.

The very important environmental problems before the World as a whole and India in particular is climate change, which is very closely associated with the global warming. They are very important on the ground that they have number of evil consequences on more or less all the spheres of the environment. It is not only India, but all the countries have been facing from the evil impacts of the climate change. It is adversely affecting the segments of the environments such as atmosphere, land, water and living things. Besides this the climate change is also adversely affecting the productive activities and sectors in the economies of the number of countries in the world as whole. It is therefore climate change has become at this moment a very importantly environmental problem of the globe as whole. And in the era of globalization and liberalization all countries of world are very closely interlinked and inter connected with the each other and India cannot be an exception to it (Kamble , 2015). Hence India also has been severely affecting from the evil consequences of the climate change. It is a well-known fact that at this moment also India is an agricultural country with over dependence of the people on agriculture as a means of lively hood, a major source of employment and a major population living in rural areas, whose prime economic activity is agriculture.

3.2. Selection of the Sample

According to the report of Climate Profile of Tamil Nadu 2020 The average annual temperature in India had risen by 0.6 degrees Celsius over the last century monsoon rainfall has decreased in many parts of the country over the last three decades of the twentieth century while others have shown an increasing trend in the observes frequency of heavy

precipitation events. Tamil Nadu's climate is noticeably different from the rest of the country. The state is fully reliant on rains to replenish its water resources; monsoon failures cause acute water scarcity and catastrophic drought. Tamil Nadu features India's third-longest coastline also suffered from the issues (Saravanakumar. V, 2015). Crop failures are exacerbated by coastal flooding caused by sea-level rise and saltwater intrusion into the coastal aquifers. Agriculture's performance is viewed as an effective tool for achieving equitable economic growth and poverty reduction. In terms of the productivity of important crops, Tamil Nadu outperformed amoung other major states. It ranks second in paddy productivity, next to Punjab, and first in maize and oilseed production. The productivity of sugarcane in Tamil Nadu was nearly double that of the national average. Thus climate change can have a wide range of effects on agriculture in Tamil Nadu making it important. Better agriculture achievements are the consequence of continuing technology advancements as well as suitable government policies and timely intervention actions.

3.2.1.a Selection of the Study Area

Climate is tropical with little difference in summer and winter temperatures and hot temperatures during the monsoon season. Frequently susceptible to harsh weather conditions, such as flooding in coastal districts and severe droughts in some places due to monsoon failure, which has a negative impact on food grain production and productivity. Drought, water scarcity, soil erosion, seawater intrusion, forest fires, species extinction, and thermal discomfort among other things are key indicators of climate change. Agriculture still continues to be a dominant sector and provides livelihood to nearly 45 per cent of the people. But its share has eroded to 8.0 per cent of GSDP in 2011-12 from 13.0 per cent in 2002-03. Global development experience reveals that one per cent growth in agriculture is at least two or three times more effective in reducing poverty than the type of same growth emanating from non-agricultural sector. During the period 2000-11, this sector registered negative growth in five years and positive growth in six years shows the vulnerability of the sector and is also a cause of distress arising due to the instability in production and productivity(State Action Plan on Climate Change, 2013). A comprehensive package combining several components to revitalize the sector should be designed to enhance the productivity working within the water constraints and stabilizing or enabling inter and intra seasonal risk proofing of rain fed production systems.

Diversification of Agriculture into Animal husbandry, Non-food crops, Horticulture, Floriculture and Sericulture has the potential to enhance the farm incomes. The food consumption basket is getting increasingly diversified and though cereal baskets dominate, this dominance is being eroded by rising expenditure on fruits, vegetables, milk, egg, meat and fish, which is the "High Value" segment, and this transformation, is in tune with development expectations. There are 13 coastal districts and 591 fishing villages with a total marine fisher population of about 8.92 lakh, of which 2.60 lakh fisher men are actively engaged in fishing. Hence, it becomes imperative to enhance the incomes of the fisher folk by augmenting marine and inland fish production through innovative technologies. The output from the agriculture sector should be reflected in higher rural incomes leading to improved health and nutrition status. Non-farm income such as post-harvest operations, maintenance of farm equipment, etc. offer a virtuous cycle connecting expansion of farm activity to that of rural non-farm income opportunities.

Tamil Nadu is the largest producer of flowers in the country. Technology break-through in horticultural crops has improved the quality and yield considerably, besides, bringing higher income to the farmers leading to crop diversification. Though the area under horticultural crops is less than one fifth of total cropped area, its share to total agricultural growth has become significantly high. In Tamil Nadu, of the 5.75 million ha of cultivable area, around 3.3 million ha falls under dry land agriculture. Millet crops such as jowar, bajra, maize, ragi and other minor millets; Pulses such as black gram, red gram, green gram, horse gram and cowpea; Oilseed crops such as groundnut, gingelly, sunflower and castor are best suited for these dry land as they are mostly grown under rain fed conditions. For example, maximum irrigated area is available for ground nut which is 38 per cent of the gross cropped area. Rest of the crops has only irrigated areas ranging between 1 per cent to 12 per cent of gross sown area. As a result the yield gaps between irrigated and rain fed conditions for these crops vary between 41 per cents in Maize to 100 per cent in Jowar. About 80 per cent of the areas under these rain-fed crops are grown during Kharif season, specifically during June to July months (South West Monsoon period which has lower rainfall than the North East monsoon in Tamil Nadu). But uncertainty in production due to fluctuations in total rainfall and changes in its distribution, decrease in relative productivity in rainfed lands affect the livelihoods of poor and marginal farmers.

The major challenges of the agriculture sector in the State are related to its high dependency on rainfall for irrigation, soil fertility, low level of farm mechanization due to small land holdings and now climate change. In Tamil Nadu, nearly 50 per cent of net sown

area is under rainfed cultivation. Inadequate, untimely and polluted irrigation water source cripples production and productivity of crops; monsoon vagaries compound the problem. With exhausted nutrients and microbes, depleted organic carbon status and humus levels, the soil deterioration is unabated. Chemical invasive agriculture, development of sodic and alkaline soils, use of salty water drawn from deeper layers through bore wells are adding further complexities. Shrinking agriculture land mainly due to urbanization and industrialization accompanied by repeated monsoon failures is a concern for meeting food demand in the state. Though the vision of the state is to move towards farm mechanization for maximizing production, the size of farm holding continues to become smaller, currently it is 0.83 ha in Tamil Nadu.

While growth in the horticulture sector has been satisfactory, there are number of factors retarding implementation of advance technologies for promoting horticulture productivity such as Non-availability of crop specific/ location specific technologies; High investment cost cannot be incurred by small and marginal farmers despite government support; Firm mind set of farmers in favour of traditional agriculture; Non-availability of quality inputs required for high tech agriculture; Non availability of inputs in time; Less availability of credit support to most of the small and marginal farmers. The state over the years has become vulnerable to various natural disasters, which is a serious concern to the planners. Agriculture is the predominant occupation in Tamil Nadu and is closely dependent on the endowment of natural resources and environmental conditions. Because of its geographical position under climate variability situation, Agriculture in Tamil Nadu is affected by Frequent cyclone; Rain dark areas to South west monsoon except the Nilgris, Salem Dharmapuri, Krishnagiri and Kanyakumari districts; Failure of North east monsoon leading to frequent occurrence of drought and flood occurrence; and Inter annual variability in Inter State river flow affecting the surface water source available for irrigated agriculture. Current estimates of Demand and Supply gap of important crops in Tamil Nadu for the year 2010 (Tamil Nadu State Planning Commission, 2019) indicated that the State is lagging far behind in the production of various crops. As the production and productivity of crops mainly depend on the climatic conditions that prevail during the growing period, it is important to understand the changes that have happened in the climate and its related impact on agricultural production and plan agriculture as per the future anticipated changes in climate.

The State government will encourage crop diversification through cultivation of millets and pulses as 29 districts in the State have been identified as vulnerable to the impact of global climate change. In Coimbatore district “Special schemes will be implemented to

popularize the cultivation of millets and pulses as an alternative to water-intensive crops. Under the Crop Diversification Programme, farmers will be encouraged to cultivate high value, short-duration crops as an alternative to low-value crops, after harvesting field crops (District Diagnostic Study Coimbatore District, 2019). Maize and sorghum have a huge demand for poultry feed production and raw material for value addition for bakery products. Due to its low cost of cultivation and low water requirement it is preferred under rainfed conditions in the dry land area of the district. Therefore, there is scope for increasing the productivity and production of millets through appropriate technologies like distribution of quality seeds and demonstration of technologies. Seed production and Millets food processing provide good scope for enterprises. Coconut is the major crop grown in the district accounting for 44 per cent of the gross cropped area. Neera production, Small cold pressed copra oil processing units, establishing coconut nurseries have huge potential in the district. Pulses seed production, processing of pulses and Increase in the productivities of pulses has high scope in the district. Tomato and Onion have high scope in Thondamuthur, Annur and Karamadai blocks which requires less water. Curry leaf production is high in Periyanaickenpalyam, Annur and Karamadi blocks by using drip irrigation. Jasmine is yield is high in Karamadai, Periyanaickenpalyam and Annur blocks. Jasmine processing unit is located in Periyanaickenpalyam block. In medicinal and aromatic plants Aloe vera and thulasi are cultivated in all blocks.

(b) Profile of Coimbatore District

Coimbatore District lies north of Tamil Nadu. Coimbatore District is situated between 11°00’58” and 11°01’61” North latitude and 76°58’16” and 76°09’71” East longitude. Coimbatore District consists of ten taluks viz., Coimbatore Corporation, Coimbatore South, Coimbatore North, Pollachi, Pollachi Municipality, Sulur, Valparai, Mettupalayam, and Mettupalayam Municipality. There are 3 Municipalities in the District viz. Mettupalayam, Pollachi, Valparai. There are 37 Town Panchayats and 227 village Panchayats declared on 2011 census and 295 revenue villages. There are 12 Community Blocks in the District. The District in generally is characterized with a pleasant and salubrious climate (Coimbatore District Profile -CDP, 2019). The soils of the district are mostly red soil and black soil with moderate amount of sandy coastal alluvium.

Administrative set up in Coimbatore District

Coimbatore district was one of the largest districts in Tamil Nadu. The administration set up was divided into three revenue divisions and consisted of two hundred and ninety-five villages for effective management. The following table- (15) shows the administrative set up in the Coimbatore district.

Table-15

Administrative set up in Coimbatore District

Area in hectares
Villages in numbers

S.No	Name of the Blocks	Area	Villages
1	Anamalai	15.67	19
2	Annur	4.09	21
3	Karamadai	4.35	17
4	Kinathukadavu	3.02	34
5	Madukkarai	4.37	9
6	Periyanayakan Palayam	8.33	9
7	Pollachi North	12.93	39
8	Pollachi South	10.53	26
9	Sakarsamakulam	7.07	7
10	Sulthanpettai	11.09	17
11	Sulur	4.38	21
12	Thondamuthur	12.12	10

Source: Census Report, (2011).

Demographic Profile

In 2011, Coimbatore had a population of 3,458,045 of which males and females were 1,729,297 and 1,728,748 respectively (the male is higher than the female population). The rural population of the district was formed by 24.27 per cent of which males (4,19,032) and females (4,20,073) respectively. The following table - (16) shows the population details of the Coimbatore district at block-wise.

Coimbatore District Map

Selected Study Block

Selected Study Block

Source: Coimbatore District Profile (2019).

Figure: 4

Table-16
Details of Population in Blocks of Coimbatore District

(in per cent)

S.No	Name of the Blocks	Population		
		Male	Female	Total
1	Anamalai	7.00	13.49	13.45
2	Annur	9.05	4.56	4.57
3	Karamadai	13.42	9.84	9.97
4	Kinathukadavu	9.32	2.92	2.91
5	Madukkarai	4.59	6.47	6.46
6	Periyanayakan Palayam	10.11	7.05	7.02
7	Pollachi North	10.03	9.38	9.35
8	Pollachi South	8.01	10.19	10.11
9	Sakarsamakulam	2.91	8.14	8.08
10	Sulthanpettai	7.58	9.05	9.05
11	Sulur	11.50	11.27	11.38
12	Thondamuthur	6.46	7.58	7.57

Source: Coimbatore District Profile, (2020).

Total workers in the district increased from 44 per cent of the total population in 2001 to 45 per cent in 2011, while in the State the workers increased from 45 to 46 per cent in the same period. The percentage of workers in the district was marginally lower than that of the State. In absolute terms, the total number of workers increased from 12, 95,568 in 2001 to 15, 67,950 in 2011, registering a 21 per cent increase in a decade. The classification of workers in the district is given in the following table- (17).

Table-17

Details of Workforce Participation in Coimbatore District

(in numbers)

Coimbatore District Blocks	Total workers	Cultivators	Agricultural labourers	Household industry workers	Other workers
Karamadai	70469	11408	21915	4187	32959
Madukkarai	18145	3637	5438	362	8708
Periyanaickenpalayam	24463	2143	4298	674	17348
Sarkarsamakulam	15128	1738	4357	393	8640
Thondamuthur	24521	2712	11269	480	10060
Anaimalai	39469	2495	21409	704	14861
Kinathukadavu	50771	8990	19427	1235	21119
Pollachi North	52831	4455	22092	1978	24306
Pollachi South	36576	3733	14915	1356	16572
Annur	49972	8746	15654	2211	23361
Sulur	25101	2496	3584	1224	17797
Sulthanpet	44842	9941	16087	3465	15349

Source: Coimbatore District Profile, (2019).

It could be seen from above table- (18) that the district has only 6,647.1 ha of geographical area under forest. Being an urbanized district with a strong industrial and educational infrastructure area under agricultural use is 164517.9 ha. Another area of concern is the area under current fallows 39981.69 ha and other fallow land is 62851.87. The total geographical area of the district is 367097.9 ha, of which the total cropped area accounts for 170202.74 ha. Fallow and land put for other uses account for 62851 ha and 76748.45 ha respectively in the district.

Table-18

Land Use Pattern in Coimbatore District

(area in hectares)

S.No	Classification	Area
1	Forest	6647.130
2	Barren and Uncultivable uses	4798.308
3	Land put to Non-Agricultural uses	76748.455
4	Cultivable Waste	8152.444
5	Permanent Pastures and Other Grazing Land	76.955
6	Land Under Miscellaneous Tree Crops and Grooves	3323.166
7	Current Fallows	39981.697
8	Other Fallow Land	62851.871
9	Net Area Sown	164517.914
10	Geographical Area according to Village Records	367097.940
11	Total Cropped Area	170202.744
12	Area cropped more than once	5684.830

Source: District Statistical Handbook, (2017-18).

Land Use Pattern in Coimbatore District

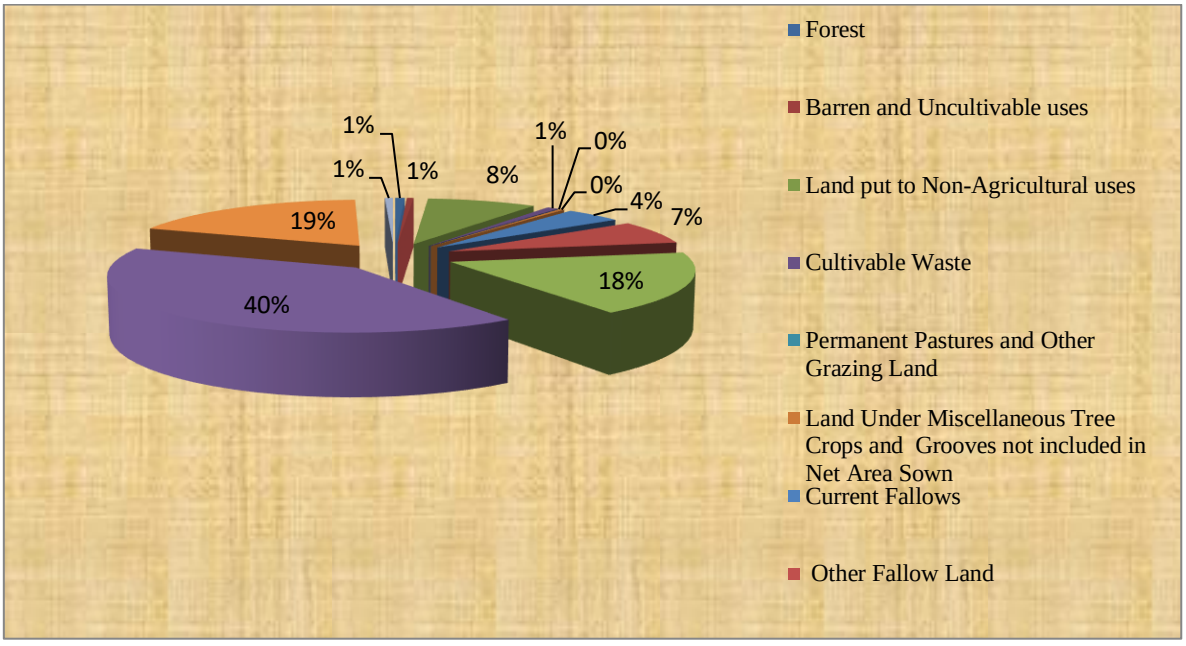


Figure: 5

"Marginal farmers (less than 1 hectare), Small farmers (1.01 to 2.0 hectares), Semi-Medium farmers (2.01 to 4.0 hectares), Medium farmers (4.01 to 10.0 hectares), and Large farmers (more than 10 hectares). Marginal and small farmers were in the small farm category (Less than 1 ha to 2 ha), semi-medium and medium farmers grouped, the medium farm size category (2 to 10 ha), and farmers with more than 10 ha given the name large farm size category (Agriculture Census Report, 2019)".

The district has 1.31 lakhs of land holdings with 2.37 lakhs ha of the area resulting in an average size of holdings of 1.81 hectares. The details of the classification of operational holding of land in the Coimbatore district are given in table- (19) revealing that 46.36 per cent of the landholdings are marginal and the remaining 27.70 per cent are small. The holdings of less than two hectares formed 74.06 per cent of the total holdings indicating that the majority of the farmers belong to the small farmer category.

Table-19

Details of Operational Holdings in Coimbatore District

Area in hectares

Holdings in number

S.No	Farmers Category	Operational area	Holdings
1	Marginal	50297.03 (12.64)	92313 (42.08)
2	Small	92971.36 (23.37)	64382(29.35)
3	Small-Medium	153911.00 (38.68)	50748(23.13)
4	Medium	72122.32 (18.12)	10775(4.91)
5	Large	52425.30 (13.17)	2425(1.10)
	Total	397882.75 (100)	21935(100)

Source: Coimbatore District Profile, (2019).

Soil in Coimbatore District

The soil in the district is mostly constituted of red sandy and mixed gravel. The rocky sub-soil and limited black and red soils are found in the district. The fine soil being of loamy variety requires only a little irrigation, commonly suitable for cotton cultivation is found only in very few areas of Coimbatore and Pollachi taluks. There are five major types of soils found in the district. Red loam is mainly found in Anaimalai, Pollachi north and south, and parts of Thondamuthur blocks. Laterite soil is mainly found in the Valparai block. Black soil is mainly found in Periyanayakampalayam, Sulthanpet, Parts of Sulur, Sarkarasamakulam and parts of Madukkarai blocks. Red Sandy Soil is mainly found in Thondamuthur, Madukkarai, Kinathukadavu, and Karamadai, blocks. Calcareous Soil is mainly found in S.S.Kulam, Annur, Periyanayakampalayam and parts of Sulur blocks. The type of soil in the district is presented in the following table- (20).

Table-20

Details of Soil in Coimbatore District

S.No	Name of Blocks	Type of Soil
1	Anamalai	Red loam, Black soil
2	Annur	Red loam, Black soil, Red Sandy, Calcareous soil
3	Karamadai	Red loam, Sandy coastal alluvium
4	Kinathukadavu	Red loam, Black soil
5	Madukkarai	Red loam, Black soil, Sandy coastal alluvium, Red Sandy soil
6	Periyanayakan Palayam	Red loam, Black soil, Sandy coastal alluvium, Red Sandy soil
7	Pollachi North	Red loam, Black soil
8	Pollachi South	Red loam, Black soil
9	Sakarsamakulam	Red loam, Black soil, Sandy coastal alluvium, Red Sandy soil
10	Sulthanpettai	Red loam, Sandy coastal alluvium, Red Sandy soil, Calcareous soil
11	Sulur	Red loam, Black soil, Sandy coastal alluvium, Red Sandy soil
12	Thondamuthur	Red loam, Black soil, Sandy coastal alluvium, Red Sandy soil

Source: Coimbatore District Profile, (2019).

Rainfall in Coimbatore District

The normal rainfall of the district is around 650 to 700mm. The highest per centage of rainfall of 44 per cent of the total rainfall is received during the north-east monsoon, whereas the district receives 37 per cent of southwest monsoon and 17 per cent of the summer season rains. However the several dams filled by south west monsoon in the Western Ghats that benefit the district and also contributes only about one-third of the total rainfall of the district. The rainfall during the southwest monsoon in the plains would be much lower. The rainfall during the winter season is negligible. Rainy months of the district can be grouped into three seasons. Summer season from March to May, South-West monsoon from June to the middle of September, North-East monsoon from October to December. The following table- (21) shows the Rainfall (in millimeter) during different seasons in 2018-19.

Table- 21

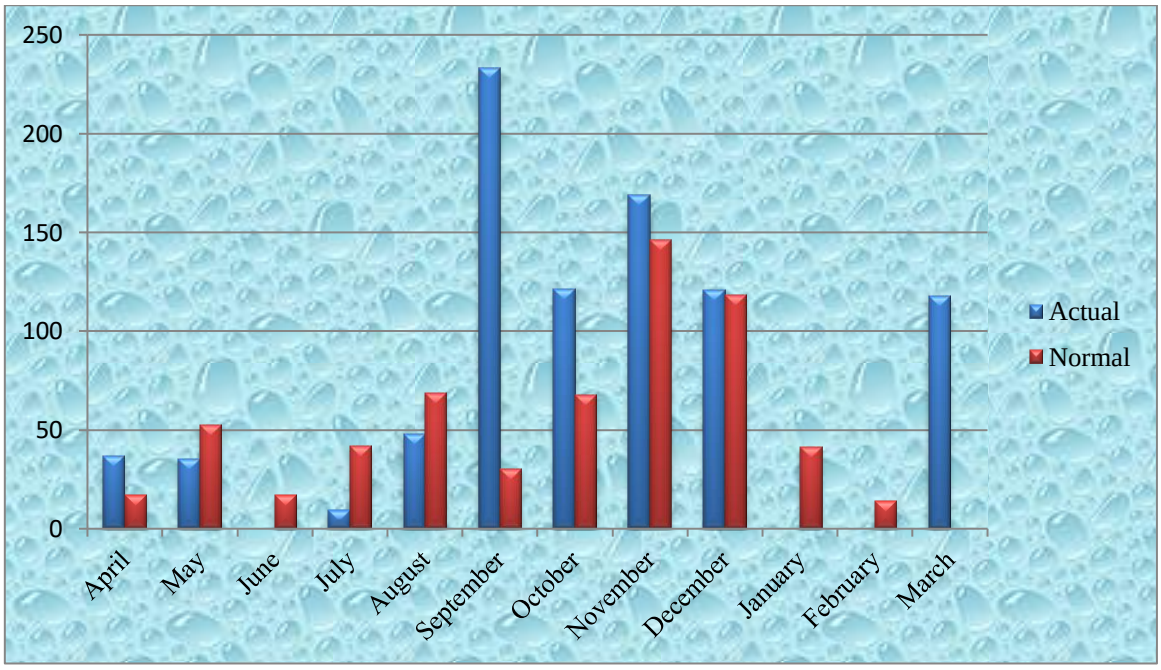
Rainfall in Coimbatore District

(in mm)

Month	Actual	Normal
April	36.8	17.0
May	35.5	52.7
June	0	17.0
July	9.3	42.0
August	47.8	68.5
September	233.1	30.1
October	121.2	68.0
November	168.8	146.0
December	120.8	118.0
January	0	41.4
February	0	14.0
March	117.6	9.2

Source: Coimbatore District Profile, (2019).

Rainfall in Coimbatore District in 2019



Source: Coimbatore District Profile, (2019).

Figure: 6

Temperature in Coimbatore District

The minimum temperature is in the summer months of April and May the minimum temperature is 23.40^{0}C and the maximum temperature is 34.85^{0}C resulting in a mean average temperature in summer of 29.12^{0}C. Similarly, during the winter periods of October to March the minimum temperature is 19.85^{0}C and the maximum temperature is 30.83^{0}C resulting in a

mean average temperature in winter of 25.34^{0}C. During rainy periods of June to September the minimum temperature is 22.45^{0}C and the maximum temperature is 31.52^{0}C resulting in a mean average temperature in the rainy season of 26.99^{0}C. All together Coimbatore enjoys pleasant weather throughout the year. The district has a very pleasant climate. In the district, the maximum temperature is recorded in April and the minimum temperature is recorded in December. The following table- (22) shows the temperature (in degree Celsius) and humidity at Coimbatore station in 2018-19.

Table-22

Details of Temperature in Coimbatore District

Temperature in º C
Humidity in per cent

Month	Maximum		Minimum		Humidity	
	Actual	Normal	Actual	Normal	Actual	Normal
April	37.04	29.4	25.08	17.9	41.23	61
May	36.35	31.8	25.01	18.5	47.76	55
June	31.05	34.5	22.55	20.5	57.75	50
July	31.76	35.2	23.07	23.8	59.09	54
August	31.83	34.0	23.18	23.2	61.32	55
September	31.22	31.0	22.92	22.9	64.62	56
October	31.25	30.1	11.85	22.2	61.0	55
November	30.84	30.1	22.85	22.2	60.97	62
December	29.76	31.6	20.316	21.8	54.04	63
January	30.46	30.9	19.62	21.4	40.48	72
February	32.68	29.2	20.46	20.2	39.3	73
March	34.75	29.4	22.69	17.9	41.0	77

Source: Coimbatore District Profile, (2019).

Cropping Pattern in Coimbatore

Agriculture is the common activity in rural areas of the district, being considered an industrially developed one. Cultivated areas of the district can be divided into three types; wet, garden, and dry. The wet type includes the area under cultivation of paddy, sugarcane, turmeric, and betel vine. In the garden lands, the crops under cultivation are cholam, ragi, groundnut, chilly, onion, tobacco, vegetables, flowers, and grapes. In the dry lands, the crops include cholam, cotton, cumbu, horse gram, Bengal gram, pulses, and groundnut. Dry crops like cereals and pulses formed a good percentage of the cultivated area. Rice which needs good soil and irrigation does not form the staple produce of Coimbatore, even though it is cultivated in Pollachi taluks and to a lesser extent in Coimbatore taluks. The area, production, and productivity are given in the following table- (23).

Table - 23

Area, Production and Productivity of Major Crops in Coimbatore District

Net Area Sown (ha)
Production (tonnes/ha)
Productivity (kg/ha)

Major Crops	Net Area Sown	Production	Productivity
Paddy	5200	20100	3865
Cholam	38200	41900	1097
Cumbu	300	500	1667
Ragi	100	200	2000
Maize	17500	68500	3914
Others	700	500	714
Redgram	575	359	624
Black Gram	3220	2013	625
Greengram	1662	1039	625
Horse Gram	3148	1968	625
Others	9039	5650	625
Groundnut	17050	35600	2088
Gingelly	610	367	602
Sunflower	50	63	1260
Caster	150	50	333
Soyabeen	50	50	1000
Cotton	1000	4000	708
Sugarcane	2000	270000	135000

Source: Coimbatore District Profile, (2019).

The gross cropped area and the net sown area were 1.77 Lakh hectares and 1.74 Lakh hectares during 2015-16. The major annual crops raised in the district include sorghum, banana, groundnut, paddy, maize, and pulses. Out of the net sown area, 68 per cent is irrigated and the balance is rain-fed. The major perennial crops raised in the district are Coconut (49 per cent of the net area sown) and Tea (6.5 per cent of the Net Area Sown). Other than these two crops, pulses, fresh fruits, spices, and vegetables are the major groups of crops raised in the district.

Irrigation

Agriculture in the district depends on rain except for the land adjoining rivers. Land areas in the district are mostly hard rocky terrain and the groundwater potential of the district is very limited. The water from the black soil and Kankari tracts in Coimbatore taluk is not much useful for cultivation. Rivers, rain-fed tanks, and wells are the major sources of irrigation in the district. Cauvery River and its tributaries viz., Noyyal, Bhavani, and Amaravathi play a very crucial role in irrigation in the district. The sources of irrigation are shown in the following table- (24).

Table- 24

Sources of Irrigation in Coimbatore District

S.No	Particulars	Numbers
1	Canals	27
2	Tanks	48
3	Open Well	51786
4	Bore Well	13564
5	Tube Well	-
6	Others	-

Source: Coimbatore District Profile, (2019).

Tanks are playing a significant role in the irrigation of the district. The fine soil being of the loamy variety requires only a little irrigation. Well irrigation is normally practiced in Coimbatore and Pollachi taluks. The rainfall in this region is much less than in the adjoining districts. The Agriculture Engineering department is engaged in the popularization of improved water-saving systems like sprinkler and drip irrigation. The following table- (25) gives the source-wise net area irrigated in hectares in the district.

Table- 25

Net Area Irrigated in Hectares in Coimbatore District

S.No	Particulars	Area in Hectares
1	Canals	21870
2	Tube Well and Other Wells	22012
3	Open Well	66921
4	Others	1161
5	Total	111964

Source: Coimbatore District Profile, (2020).

During 2015-16, the gross cropped area and net sown area were 1.77 lakh ha and 1.74 lakh ha, respectively. Sorghum, banana, peanuts, paddy, maize, and pulses are among the principal annual crops grown in the area. Sixty-eight per cent of the net sown land is irrigated, while the remainder is rainfed. Coconut (49 per cent of net sown area) and tea are the two most important perennial crops grown in the district (6.5 per cent of Net Sown Area). Aside from these two commodities, the district's principal crop groups are pulses, fresh fruits, spices, and vegetables.

3.2.2. a) Selection of the Study Blocks

As the study was mainly based on primary data, the sampling respondents in the study were selected through multistage systematic stratified sampling techniques. The study was restricted only to Coimbatore District. In the first stage the 12 blocks in Coimbatore district viz, Anamalai, Annur, Karamadai, Kinathukadavu, Madukkarai, Periyanaickenpalayam,

Pollachi North, Pollachi South, Sarkarasamakulam, Sulthanpet, Sulur, and Thondamuthur. Among the 12 blocks, the researcher has chosen the per cent of the irrigated area to the total cultivable area. Through these blocks, the study was selected Thondamuthur and Annur blocks under a higher and lower level of percentage of irrigated area to total cultivable area and the same are shown in the following table- (26).

Table- 26

Details of per cent of Irrigated Area to Total Cultivable Area

(in Hectares)
(Cultivable area to total area in per cent)
(Irrigated area to total cultivable area in per cent)

Blocks	Total Area	Cultivable Area to Total Area	Irrigated Area to Total Cultivable Area
Karamadai	38244.84	34.26	60.86
Madukkarai	9999.27	53.53	62.2
Periyanaickenpalayam	10632.73	22.78	70.84
Sarkarsamakulam	7386.69	46.51	40.06
Thondamuthur	**10682.58**	**50.85**	**80.59**
Anaimalai	20340.39	75.05	79.91
Kinathukadavu	31552.1	57.36	69.59
Pollachi North	25702.25	75.94	76.13
Pollachi South	17267.52	70.39	72.34
Annur	**27061.1**	**50.62**	**33.5**
Sulur	10701.33	34.74	50.15
Sulthanpet	29574.62	47.21	74.73

Source: CDP, (2020).

Percentage of Irrigated Area to the Total Cultivable Area

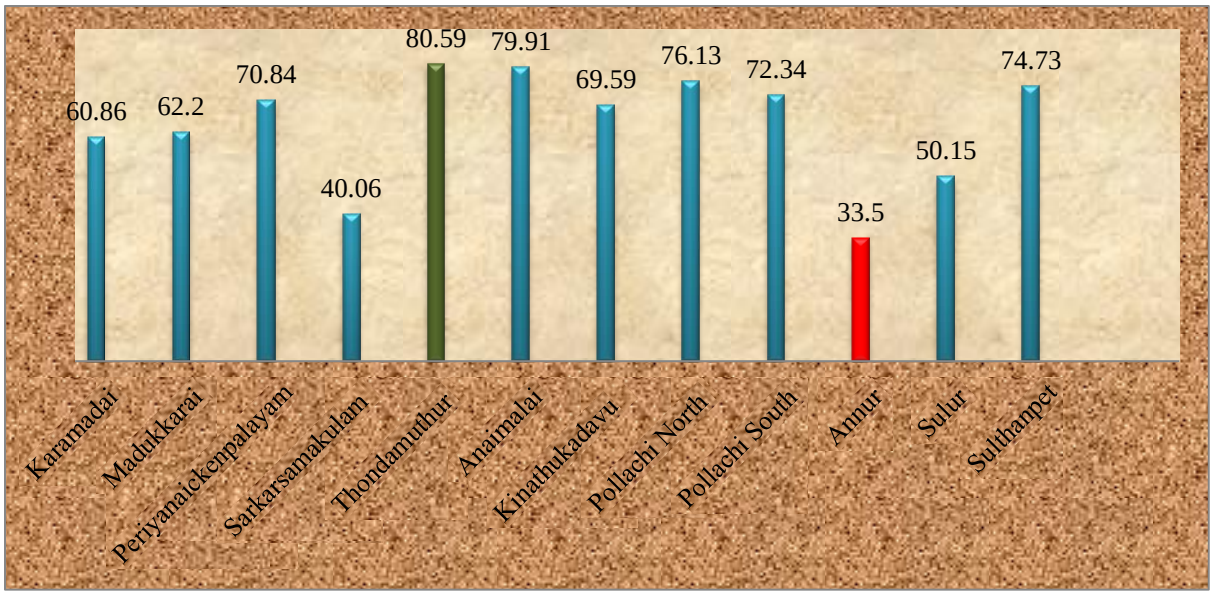


Figure: 8

Profile of the Study Blocks

The general characteristics of the study blocks are provided in the table- (27). Thondamuthur block has 10 revenue villages while Annur block has 22 revenue villages. The population in Thondamuthur is 66,080 while that of Annur is 1, 01,068.

Table- 27

General Characteristics of Selected Study Blocks

S.No	Particulars	Thondamuthur	Annur
1	No. of. Villages	10	22
2	Total Population	66080	101068
3	Male	33009	51051
4	Female	33071	50017
5	Total area (in Hectares)	10682.58	29060
6	Total Literates (in per cent)	65.43	57.89
7	Number of schools	67	134
8	Number of hospitals	8	13
9	Number of police station	2	1
10	Number of post offices	83	89
11	Number of banks	4	16
12	Number of veterinary hospitals	16	5

Source: Coimbatore District Profile, (2019).

The workers in the Thondamuthur block are 24,521 persons, of which, cultivators account for 2,712, agricultural labourers are 11,269, households industries constitute 480 and other workers are 10,060. In the Annur block, the total workers are 49,972 persons, of which, cultivators account for 8,746, agricultural labourers are 15,654, household industrial workers constitute 5,000 other industry workers are 2,211 and other workers were 23,361 is given in the table- (28).

Table- 28

Workers Classification of the Selected Study Blocks

(in numbers)

S.No	Particulars	Thondamuthur	Annur
1	Cultivators	2712	8746
2	Agricultural labourers	11269	15654
3	Household industry workers	480	2211
4	Other workers	10060	23361
5	Total workers	24521	49972

Source: Coimbatore District Profile, (2019).

Land utilization of the selected study blocks is given in the following table- (29). The total geographical area of the Thondamuthur block is 10682.58 hectares, of which, the net area sown was 5432.2 hectares, forests accounted for 0.9 hectares, barren and uncultivable

land accounted for 69.7 hectares, land put on non-agricultural uses were 35.3 hectares, 781.1 hectares were a cultivable waste, Permanent pasture, and other grazing lands were non-miscellaneous tree crops and current fallows 1455.7 hectares. In the Annur block, the total geographical area is 27061.1 hectares, of which, the net area sown was 13697.3 hectares, barren and uncultivable land accounted for 11.4 hectares, land put on non-agricultural uses was 348.6 hectares, 459.8 hectares were a cultivable waste, current fallows 9185.4 hectares respectively.

Table- 29

Land Use Pattern in Selected Study Blocks

S. No	Particulars	Thondamuthur	Annur
1	Forests	0.9	0
2	Area under Non-agricultural Uses	1456.4	3261.5
3	Barren and Un-cultivable land	69.7	11.4
4	Permanent Pastures and Other Grazing Lands	0	12.6
5	Land Under Miscellaneous Tree Crops etc.	35.3	54.9
6	Cultivable Waste Land	781.1	348.6
7	Fallow lands other than current fallows	1450.9	489.4
8	Current Fallows	1455.7	9185.4
9	Net Area Sown	5432.2	13697.3
10	Total Geographical area	10682.58	27061.1

Source: Coimbatore District Profile, (2019).

The data in table- (30) revealed that 74.24 per cent of the holdings (Marginal and smallholders considered as smallholders) are small whereas 24.65 (Small-Medium and Medium holders considered as Medium holders) are medium holders, 1.11 per cent are the large size of landholders in Thondamuthur block. In the Annur block, 71.83 per cent of the holdings (Marginal and smallholders considered as smallholders) are small whereas 27.52 (Small- Medium and Medium holders considered as medium holders) are medium holders, 0.64 per cent are the large size of landholders.

Table-30

Details of Land Holdings in Selected Study Blocks

S.No	Classification category	Size of Holdings	
		Annur	Thondamuthur
1	Marginal	6126 (42.67)	4516(45.98)
2	Small	4187(29.16)	2776(28.26)
3	Small-Medium	2875 (0.02)	1693(17.24)
4	Medium	1077(7.50)	728 (7.41)
5	Large	92(0.64)	109 (1.11)
	Total	**14357**	**9822**

Source: Coimbatore District Profile, (2019).

The area irrigated by different sources of irrigation is furnished in table- (31). It is observed that the groundwater sources through private tube wells and ordinary wells are the major sources of irrigation in both the study blocks.

Table- 31

Area Irrigated by Different Sources in the Selected Study Blocks

(in hectares)

S.No	Particulars	Thondamuthur	Annur
1	Total Irrigated Land Area	4377.9	4588.8
2	Total Un-irrigated Land Area	1054.5	9108.7
3	Canals (C)	270	0
4	Wells/Tube-wells	4107.9	4288.6
5	Tanks/Lakes	0	265.8
6	Water Falls	0	0
7	Others	0	34.4

Source: Coimbatore District Profile, (2019).

The total irrigated land area is 4377.9 ha where un-irrigated area accounts for 1054.5, canals as 270 and wells and tube wells accounted for 4107.9 in Thondamuthur block while in Annur block total irrigated land area is 4588.8 ha where un-irrigated area accounts for 9108.7, wells and tube wells accounted for 4288.6 and tanks and lakes as 265.8 and others sources account for 34.4 respectively.

Cropping Pattern in Selected Blocks

Paddy is mostly cultivated in the Anaimalai and some extent in the Thondamuthur block. The cereals like cholam is un-irrigated and listed in top of all the blocks, while maize is grown both in irrigated and un-irrigated conditions in all the blocks. In the Karamadai and Thondamuthur block Banana is considered as major commercial crop of 3264 and 1215 hectare and also it is cultivated in all blocks. Tomato groundnut and coconut also cultivated in all blocks. The soil is suitable for cultivation and also face labour problem in the district (CDP, 2018). Paddy crop is cultivated amoung the block of Anamalai as 92.31 per cent of cultivated area. Karamadai and Pollachi has cultivated 70 per cent of Cumbu and Cholam cultivation has 13.88 per cent in Annur, 12.62 per cent in Karamadai. The area under maize of 31 per cent of Sulthanpet and Ragi is cultivated 50 per cent in Karamadai while pulses like horse gram, green gram, and red gram are predominant in Annur, Kinathukadavu and Karamadai blocks. Cotton is highly cultivated in Madukkarai, Kinnathukadavu and Annur

blocks and in which nearly 25 per cent in Anamalai and 21 per cent in Annur block engaged in sugarcane cultivation.

Productivity of Crops

The crop productivity is low in four tonnes per hetare of paddy while Annur has 4.5 tonnes per hectare which is higher than the district paddy productivity and 4.68 tonnes per hectare of pulses. Banana and Cabbage was higher productivity in the district. The range of cholam productivity of 1.2 to 1.3 tonnes per hectare in the blocks amoung the pulses the red gram has higher productivity followed by the black gram in all the blocks. The groundnut productivity was high in Annur block (3034 kg) followed by 2500kg of Pollachi south, in which the P.N Palayam recorded high in cotton productivity of 4000 kg while the 26000 kg of lowest in Karamadai, Sulur, and Anamalai blocks.

Horticultural Crops

Coimbatore district has cultivated the horticulture crops like fruits, vegetables, flowers, medicinal plants covering an area of 52011 hectare. The plantation crop of coconut 28.2 per cent of the total area, Areca nut, Tea, Coffee (1577 hectare) It is reported that fruits, vegetables, flowers, medicinal plants, and horticulture crops are cultivated in the district covering an area of 52011 ha. The major plantation crops grown are Coconut (28.2 per cent of the total area), Tea, Coffee, Areca nut (1577 ha), and Cardamom. Cashew and curry leaves are also grown in a few pockets. Cocoa cultivation has also been started on a small scale as an intercrop in the coconut plantations with an area coverage of 330 ha. Mango, banana, guava, lime, papaya, and grapes are some of the major fruit crops grown in about 9894 ha. Banana is also cultivated quite extensively and has covered 4983 ha with a production of 1,45,880 MT. Mango cultivation is gaining impetus in Coimbatore. The district occupies the second position in the State in the area under grapes with 386 hectares and estimated production of 9000 MT of fruit. The Spices like chilies, coriander, tamarind, cardamom, pepper, ginger, turmeric, and cloves are also grown in about 8067 hectares.

Table- 32

Details of Area Production and Productivity of Horticulture Crops in Selected Blocks

S.No	Particulars	Thondamuthur			Annur		
		Area	Production	Productivity	Area	Production	Productivity
1	Fruits	1502	56420	37.56	1937	85923	44.36
2	Vegetables	1940	25147	12.97	927	21302	22.99
3	Spices and Condiments	383	2740	7.15	639	35393	55.38
4	Plantation crops	4664	1868	0.40	1118	357	0.32
5	Medicinal and Aromatic Plants	6	136	22.598	0	0	0.00
6	Flowers	29	497	17.02	51	644	12.58
7	Total Crops	8524	86808	97.70	4671	143619	135.63

Source: Coimbatore District Profile, (2019).

The table- (32) reveals that the area under fruit crops in the 12 blocks of Coimbatore district revealed that banana is the major crop with 2834 ha in Karamadai followed by 1060 ha in Thondamuthur and 1338 ha in Annur block. The productivity is maximum (54 tonnes per hectare) in Anaimalai and Pollachi (North) blocks and minimum (31 tonnes per hectare) in Sultanpet. The area under mango is 1046 ha in Anaimalai and is less (500 ha) in other blocks. The productivity is 7 tonnes per hectare in Kinathukadavu and Sulthanpet. Sapota is grown in more than 10 ha in Annur, Sulur, Sultanpet and S.S.Kulam. Amla is the other fruit crop raised in Karamadai, Madukkarai, Annur, Anaimalai, Sulur, and Sulthanpet blocks. Among the blocks, Annamalai, Annur, and Karamadai blocks have a larger area under fruit crops compared to the other blocks. Among the blocks in the district, Thondamuthur block has more than 1000 ha under vegetables. Tomato is the major vegetable with 739 ha in Madukkarai, 453 ha in Kinnathukadavu, and 314 ha in Thondamuthur. Onion has a major area of 553 ha in Thondamuthur. Again, Cauliflower is grown in 82 ha in the same block. Thondamuthur block has a maximum area under vegetables which was due to the nearness to Coimbatore city and the availability of irrigation. The productivity of tomatoes varied from 11 to 32 tonnes per hectare among the blocks. Greens are cultivated in 25 ha in Sultan pet block. Being a short duration and perishable crops agricultural planning should pay greater attention to marketing and value addition.

Livestock Production in Selected Farm households

The total population of cattle in the district was 577128, as per the 17thLivestock Census. Among the blocks, Sulthanpet, Anaimalai, and Pollachi (North) have a larger number

of cattle compared to others blocks. This might be due to the larger level of agricultural (horticultural) activities in these blocks. The sheep population is high in Sulthanpet, Karamadai, Sulur, P.N.Palayam, and Annur blocks and it is again a regular source of income for farmers through wool and meat. Sulthanpet is top on the blocks in the poultry population followed by Kinathukadavu while the district has 321 dairy cooperatives of livestock. All the blocks in the district have a Veterinary dispensary which helps for the effective care of livestock and poultry.

Table-33

Details of Livestock Production in Selected Study Blocks

S.No	Particulars	Thondamuthur	Annur
1	Cattle	11599	21537
2	Buffalo	255	489
3	Sheep	7906	13605
4	Goat	11496	16904
5	Poultry	186048	696800
6	Pigs	255	76
7	Dogs	6351	5837

Source: Coimbatore District Profile, (2019).

The table- (33) reveals the total livestock in the Thondamuthur block, buffaloes were 255 and cows were 11,599, poultry birds were 1, 86,048 sheep were 7,906 and goats were 11,496. In Annur block the total livestock population which, the buffaloes were 489, cows were 21,537, poultry birds were 6, 96,800 sheep were 13,605 and goats were 16,904. Every farmer Is try to maintain at least a milch animal to generate supplemental income from farming activities at generally in which there is also declining trend in the cattle population due to the increasing cost of maintenance and the non-availability of fodder. Livestock supports to make revenue for the farmers by egg, meat, and milk when the income of crops is seasonal. Sheep are a regular source of income further it facilitates wool production.

The infrastructural facilities are concerned; almost all the villages in the study blocks are electrified and have fairly good schools and adequate facilities for Thondamuthur and Annur blocks are presented in table- 34.

Table- 34

General Infrastructure of Selected Study Blocks

S.No	Particulars	Thondamuthur	Annur
Standard of Living			
1	Access to Cooking Fuel	58.04	37.99
2	Access to Toilet Facilities	61.62	64.19
3	Access to Drinking Water	95.52	97.47
4	Access to Electricity	96.20	93.33
5	Access to Pucca houses	65.36	56.72
Health			
6	Infant Mortality Rate (IMR)	11.30	7.90
7	Maternal Mortality Rate (MMR)	10.00	10.00
8	Under Five Mortality Rate (U5MR)	8.58	9.15
Education			
9	Literacy Rate	76.10	72.54
10	Primary Education	100.91	98.81
11	Secondary Education	102.71	103.52

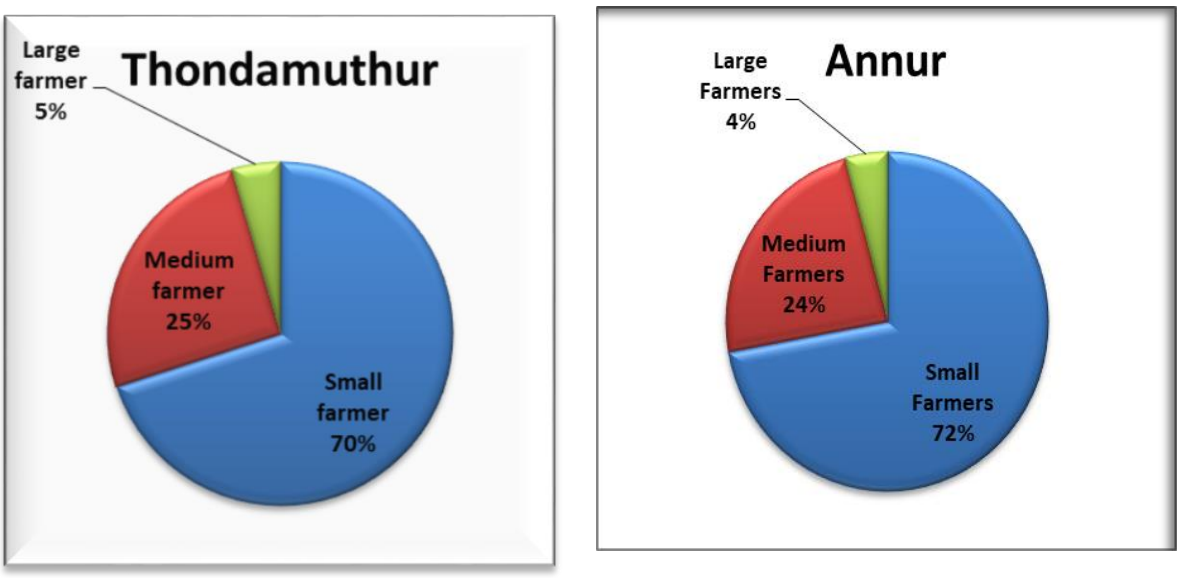
Source: District Statistical Report, (2019)

Selection of Sample Farm Households

In the selection of the sample households, the researcher first identified the higher and lower per cent of the irrigated area to the total cultivable area. It was found that the Thondamuthur block was found to have a higher percentage (80.59) of the irrigated area to total cultivable area with 10 villages and the Annur block was found as a lower percentage (33.50) of irrigated area to total cultivable area with 22 villages. The selected sample was collected from the Coimbatore district profile based on climate change and its impact on the agriculture sector from irrigated areas to the cultivable area. In the second stage, the farm households were selected on the criterion that the landholding farmers had been cultivating for at least 15 to 20 years. (723 farm households were selected randomly constituting around 5 per cent using Rao Sample Size Calculator). In stage three sample households were selected in the Thondamuthur block 386 farm households and 373 from the Annur block were selected by adopting the purposive sampling technique as not all the farm households were willing to co-operate with the investigator. Hence the investigator approached only those farm households who were willing to co-operate and supply the needed information. Totally 660 farm households were selected for the field survey from the two study blocks. There were 330 farm households in the Thondamuthur block and 330 in the Annur block were selected using a systematic stratified random sampling method. The data were collected from 660 sample holdings representing marginal farmers (less than 1 ha), small farmers (1.01 to 2.0

ha), semi-medium farmers (2.01 to 4.0 ha), medium farmers (4.01 to 10.0 ha) and large farmers (greater than 10 ha). The study undertaken that marginal and small farmers were pooled and named small farm category, and semi medium and medium farmers were pooled and named medium farm size category, while more than 10.0 ha farmers represents large size farmers. Distribution of the sample farmers based on land operational holdings in the Thondamuthur block, showed that out of 330 total sample farmers, the small farmers accounted for 72 per cent, medium farmers constitute 26 per cent and large farmers 2 per cent. In the Annur block, out of the 330 total sample farmers the small farmers accounted for 73 per cent, medium farmers 25.02 per cent and large farmers constitute 1.08 per cent. The distributions of the selected farmers from these villages are given in the following table-35.

Details of Selected Sample Households



Source: Field survey, (2019).

Figure: 9

Table-35

Details of Selected Sample Households

S.No	Village covered	Farmers			
		Small Farmers	Medium Farmers	Large Farmers	All
Thondamuthur block					
1	Devarayapuram	26	12	2	40
2	Ikkarai Boluvampatti	32	11	1	44
3	Jagirnaickenplm	28	9	1	38
4	Madampatti	31	5	2	38
5	Madvarayapuram	21	8	1	30
6	Narasipuram	22	11	2	35
7	P.C.Palayam	27	12	2	41
8	Theethipalayam	21	6	3	30
9	Thennamanallur	23	10	1	34
10	Vellimalaipatinam	26	12	2	40
	Total	**231**	**84**	**15**	**330**
Annur block					
1	Annur	12	4	1	17
2	Pillayapampalayam.	15	2	1	18
3	Kariyampalayam.	15	5	0	20
4	Vadavalli	13	2	1	16
5	Kuppepalayam	9	2	1	12
6	Kattampatty	8	3	0	11
7	Kunnathur	11	3	1	15
8	Masagoundenpalayam	14	2	0	16
9	Pachapalayam	8	2	1	11
10	Naranapuram	8	4	1	13
11	Karegoundenpalayam	10	5	1	16
12	Bogalur	11	2	0	13
13	Odderpalayam	12	5	1	18
14	Kuppanur	14	4	1	19
15	Akkari Sengapally	11	3	0	14
16	Kanuvakarai	13	2	1	16
17	Aambothi	12	7	0	19
18	Vadakkalur	10	3	1	14
19	Annur Mettupalayam	11	5	0	16
20	Pasoor	7	2	1	10
21	Allapalayam	6	8	0	14
22	Kanjampally	8	3	1	12
	Total	**238**	**78**	**14**	**330**

Source: Field Survey, (2019).

3.3. Sources and Collection of Data

The period of the study was pertaining to the agricultural year 2018-2019. The data for the study were collected from both primary and secondary sources. The district information is taken from the district profile, block profile, data on agricultural reports.

1. Coimbatore District Profile, 2019.
2. Seasonal and Crop Report, 2019.
3. Census report, 2011.
4. Block profile of Thondamuthur and Annur 2018-2019.

Primary data were collected through personal interview method from the sample farmers. Interview schedules were used to collect details related to the study from the sample farmers. A pilot study was conducted to identify the gaps in the interview schedule. On the basis of observation, the survey was conducted in 2018-19.

3.4. Quantitative Tools

The data was collected were arranged and tabulated for giving precise and concise information. Further, the following tools were applied to analyze the data.

The following tools were used for this analysis.

i) Scaling Technique

ii) Crop diversification Index.

iii) Correlation

iv) Factor Analysis

v) Technical Efficiency

Scaling Technique

Garrett's Rating Scale

Garret Rating Technique (1969) has been employed to rank the future expectation of farm households on a priority basis. The rank assigned to each item by the sample respondents have been converted into percentage scores using the Garret table. The total scores of each item thus obtained were converted into mean scores by dividing the farmer by dividing the number of farmer that responded to each item. The mean scores were then arranged in a descending order and ranks assigned. The mean scores were then arranged in a descending order and rank assigned. The percentage position of each item was computed using the given formula.

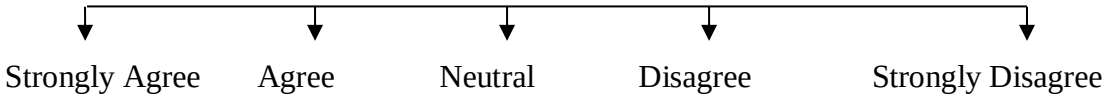
$$\text{Per cent position} = 100 * (R-0.5)/N$$

Where R is the rank assigned and N is the number of items ranked. The per cent position was then converted into scores using Garrett's scores (Garrett H, 2005).

The Garret ranking scale technique was used in prioritizing the reasons for climate change and future expectations and realizations of farm households.

Likert's Summated Rating Scale

Likert summated scaling technique was applied to find out the respondents attitude towards positive and negative aspects. In applying the Likert's summated scale, a large number of statements concerning the benefits (positive aspects) and problems (negative aspects) of the research work were listed and the respondents opinion on every statement were obtained, checking one of the following direction intensity descriptions: strongly agree, agree, neutral, disagree and strongly disagree. Each response is given a numerical weight of 5, 4, 3, 2, 1.



Each point on the scale carries a score. Response indicating the least favorable degree of satisfaction is given the least score (say 1) and the most favorable is given the highest score (say 5). These score values are normally not printed on the instrument but are shown here just to indicate the scoring pattern. The Likert scaling technique, thus, assigns a scale value to each of the five responses. The same procedure is repeated for each and every statement in the instrument. This way the instrument yields a total score for each respondent, which would then measure the respondent's favorableness toward the given point of view.

Theoretical Frame Work

Patterns of production at the early stages of development which are partly induced by geographic endowment can affect long-run growth. The importance of history for economic development is underlined by a burgeoning literature that uncovers the persistence effects of deep-rooted factors, (Nunn et.al.,2013). Geographic factors have significant effects on contemporary outcomes by shaping historical Paths of economic, social and political development (Acemoglu and Robinson, 2001). The empirical analysis takes into account land productivity and dominance of specific agricultural products, as well as other environmental conditions, distances to the coastline and main cities, and an extensive set of socio-economic variables. The results complement recent quantitative studies of history showing the persistent effect of geographical features that are no longer directly relevant. The

focus on diversification offers a distant addition to the literature on the role of agriculture on industrialization and long-run development. The results also complement the literature on diversification and growth, providing an analysis of different channels in historical perspective and a focus on the agriculture sector that permits a novel identification strategy.

Crop Diversification Index

Herfindhal Index

This index, by squaring the shares of a farm's activities, gives particular weight to the farm's principal activities. It means that a farm's secondary activities are given only limited weight in calculating the index. This index is insensitive to minor secondary activities. This is desirable since it focuses attention on the major activities of the farm. This index takes the value of one, when a farm is completely specialized in its primary activity, and should approach zero as N gets large.

The Herfindhal Index is the sum of the squares of the acreage proportion of each crop in the total cropped area. That is,

$$HI = \sum_{i=1}^{i=N} pi^2$$

It can be shown that this index attains a minimum value equal to 1/N when pi = 1/N (i = 1,2,3,….N), and N is the total number of crops, that is, when maximum diversification occurs. It attains a maximum value of 1 when N = 1, that is, when there is a single crop or when complete specialization occurs.

Modified Entropy Index (MEI)

This index weights the shares of a farm's activity by a log 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 both crop and animal 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), organizational form of the farm (with regard to types of labour used), and access to forestry. We use reasonably balanced panel data-set in which only very few farmers have been less than two years in the analysis. This index is defined as

$$MEI = - \sum_{i=1}^{i=N} p_i \log_N (p_i)$$

Hence MEI is same as EI except that the base of the logarithm is N. It can be shown that at maximum diversification, this index takes a value of 1 and at maximum specialization it attains a value of 0. The MEI provides a uniform and fixed scale and hence it is used as a norm to compare and rank the extent of diversification spatially. Hence in the present study this index has been used to rank the different coastal indices.

Technical Efficiency

The farm efficiency denotes the performance in the resources utilization. The farm performance is compared with the normative desired level or with that of any other farm. A farm refers to the being technically efficient for a given technology if it fully realizes its own technical efficiency potential by following the best practice techniques of the selected technology and creates the production frontier consistent with the socio economic physical environment. Technical efficiency (TE) is refers to the measure of firm's ratio of its actual output to the maximum possible frontier output for the level of given inputs and the given technology. The concept of technical efficiency was introduced by Farrell in 1957 and contended that the frontier production function of a firm showing the determined probable output can remain best related within the peer group and not with certain chance regular standards and free disposal convex hull of observed input-output ratios by using the linear programming technique also non parametric in nature. The Cobb- Douglas production function was estimated as deterministic parametric frontier by specifying homogenous applied by Farrell and Fieldhouse (1962), Seitz (1970) and Afrait (1972), Aiger and Chu (1968).

The deterministic models described above provide a common production frontier for all the firms and the firm's efficiency is derived by comparing the firm's performance with that of the common production frontier. The approach ignores the fact that the performance of firms was affected by exogenous factors, such as weather, considered the firm control and there is need to fulfill the problem faced by the firms. It is considered as stochastic frontier model proposed independently by Aigner et.al., (1977) and Meeusen and Van den Broeck (1977) indicated the influence of uncontrollable exogenous factors in the estimation process. The stochastic frontier has been modeled with a composite error term, comprising two components. A symmetric component permits random variation of the frontier across firms and captures the effects of measurement error, other statistical noise and random shocks outside the firm's control. A one-sided component captures firm specific effects such as slackness in production due to labour shirking, which are under the control of firms and influences their level of achievement of technical efficiency.

$$Y_i^* = f(x_{j1}, x_{j2}, \ldots\ldots x_{jn})/T$$

Where Y* and x are the frontier output and inputs of the j^{th} firm and T is the given technology that is common to the firms in the sample. If the j^{th} firm uses the best practice technique, but there are either statistical errors such as errors measured. Or influence of external factors such as weather, then the firm's frontier function is expressed as

$$Y_j^* = f(x_{j1}, x_{j2}, \ldots\ldots x_{jm})\exp(v_j - u_j)$$

Where u_j represents the combined effects of various non-price and organizational factors which constrain the firm from obtaining its maximum possible output Y^*_j . In other words, exp ($-u_j$) which is firm- specific reflects the j^{th} firms ability to produce at its present level, which is otherwise called the j^{th} firms technical efficiency . The values taken by u depend on the real situation that the firm faces. Nevertheless, an upper limit can be set for the values of u. When there are no socio economic and organizational constraints affecting the firm, u takes the values of 0. When the firm faces constraints, u takes a value greater than zero. The actual value of u depends on the extent to which the firm is affected by the constraints.

One advantage of the above model is that it is possible to find out whether the deviation of a firm's actual output from its potential output is mainly because it did not use the best practice technique or is due to external random factors. Thus one can say whether the difference between the actual output obtained and the potential frontier output, if any, occurred accidentally or not. If both the error terms are not distinguished in the estimation process, the OLS estimation can be carried out and it will give some sort of an average production function.

A measure of technical efficiency of the j^{th} firm can be defined as

$$\exp(-u_j = \frac{Y_j}{Y_j} = \frac{Actual\ output}{Maximim\ possible\ output}$$

The above equation (3) is the basic model generally used for measuring technical efficiency and it is called "the conventional frontier approach. In this approach the technical efficiency is measured on the basis of Solow's approach of measuring the growth of total factor productivity . A major difference is that unlike in the solow's approach statistical errors are removed from the residual to some extent. The assumption made by Kalirajan ans Flinn (1983), with a half normal distribution for u and a normal distribution for v, the

individual- specific technical efficiency exp(-u_j) can be estimated from the conditional expectation of exp(-u) given with the composite error term, μ as

$$E\left[\exp\left(\frac{u_i}{\mu_i}\right)\right] = -\frac{\partial_u\,\partial_v}{\partial}\,[\frac{f(.)}{1-F(.)} - \frac{v-u}{\partial}\,\sqrt{\frac{\gamma}{1-\gamma}}$$

Where f(.) and F(.) are standard normal density and distribution function respectively, and $\gamma=\gamma=\frac{\partial_u^2}{\partial^2}$ and $\partial = \partial_u^2+\partial_v^2$ where ∂_u^2 and ∂_v^2 are the variance of u and v respectively.

Correlation

Whenever a researcher has measured two variables, it is natural to ask whether or not they exhibit any "coherence" – in other words, whether they behave consistently in rising and falling in value together or whether there is no discernible pattern to their joint behavior. At the theoretical level, such co association is quantified by the covariance between two random variables. This is the expected value of the product of the deviation from the mean of each variable. If the variables rise together then the two deviations tend to be either positive together or negative together, so their products tend to be positive and the expected value yields a positive covariance (Marcin Kozak et.al., 2012). Where Y_1 is the output, X_i is the inputs and U_i is the random disturbance term, which is normally distributed with mean value of zero in the linear function as expressed by

$$Y_i=a+b_1\,X_{1i}+b_2\,X_2+\ldots\ldots+b_8X_8$$

Factor Analysis

Factor analysis is a generic name given to a class of multivariate technique and its primary purpose in to define the underlying structure in a data matrix. Broadly speaking, it addresses the problem of analysis the structure of the interrelationships (Correlations) amoung a large number of variations by defining a set of common underlying dimensions, known as factors, with factor analysis, the researcher can first identify the separate dimensions of the structure and then determine the extent to which each variable is explained in each dimension. Once these dimensions and the explanation of each variable are determined, the two primary uses for factor analysis, namely summarization and data reduction can be achieved. In summarizing the data, factor analysis derives underlying dimensions that, when interpreted and understood, describe the data in a much smaller number of concepts than the original individual variables. In the present study, factor analysis has been used to identify the underlining dimensions in climate change, crop diversification, ICTs usage and problems faced by the farm households.

Average, Percentage and Graphs

Average, Percentage and Graphs were also used in the study. To carry out the calculations in SPSS 16.0 version software is used.

3.5. Terms and Definitions

Village

The basic unit for rural areas is the revenue village, which has definite surveyed boundaries. The revenue village may comprise of one or more hamlets but the entire village is treated as one unit for presentation of data. In un surveyed areas, like villages within forest areas, each habitation area with locally recognized boundaries is treated as one village.

Cultivator

A person is classified as cultivator if he or she is engaged in cultivation of land owned or from government or from private persons or institutions for payment in money, kind or share. Cultivation also includes effective supervision or direction in cultivation. Cultivation involves ploughing, sowing, harvesting and production of cereals and millet crops such as wheat, paddy, jowar, bajra, ragi, etc., and other crops such as sugarcane, tobacco, ground-nuts, tapioca, etc., and pulses, raw jute and kindred fiber crop, cotton, cinchona and other medicinal plants, fruit growing, vegetable growing or keeping orchards or groves, etc. Cultivation does not include the plantation crops like tea, coffee, rubber, coconut and betel nuts (areca). The workers engaged in Plantation crops are recorded under other workers.

Agricultural Labour

A person who works on another person's land for wages in cash or kind or share is regarded as an agricultural labour. She/he has no risk in the cultivation, but merely works on another person's land for wages. An agricultural labour has no right of lease or contract on land on which she/he works

Forest

Forest represents all actually forested area on the lands classed or administered as forest under any legal enactment dealing with forest, whether state owned or private.

Barren and Uncultivable Land

Land in which cannot be brought under cultivation unless at a high cost whether such land is in isolated blocks or within cultivated holdings, such as mountains, deserts, hills etc. are classified as barren and uncultivable land

Land put to Non Agricultural Uses

The land put to use for purposes other than agriculture such as buildings, pathways, roads, social forests, bus stands, railway tracks, canals, rivers, local reservoirs, swamps, marshy and water logged areas, lands under still water etc.

Cultivable Waste

All lands available for cultivation whether not taken up for cultivation or taken up for cultivation once, but not cultivated during the current year and continuously for the last five years or more in succession for one reason or the other are classified as cultivable waste.

Permanent Pastures and other Grazing Lands

All grazing lands, they are permanent pastures or meadows are considered as permanent pastures and other grazing lands. Village common and grazing lands within forested area are included under this category.

Misc.Tree Crops and Groves not included in the Net Area Sown

All cultivable lands, which is not included under net area sown, but is put to some agricultural use such as lands under casuarina, eucalyptus, teak, bamboo bushes, babul, thatching grass and other groves for fuel etc. which are not included under orchards and which bear yield only once in its whole life span are classified under this category.

Current Fallow Lands

Lands that are kept fallow out of the net area sown during the previous year are classified as current fallow for the reporting year

Other Fallow Land

Land which were taken up for cultivation but have been temporarily put off cultivation for a period of not less than one year but not more than five years due to poverty of the cultivators, inadequeate supply of water, silting of canals and rivers, etc. are treated as other fallow land.

Net Area Sown

Net area sown represents the area sown under first crop during the fasli year.

Gross Area Sown

The Gross area sown represents the total area cultivated under all food and nonfood crops including the area sown more than once during the fasli year.

Area Sown More than Once

The area sown more than once represents the difference between the gross area sown under all crops and the net area sown during the fasli year.

Irrigation

Irrigation is the artificial application of water to the soil for growth of plants.

Canals

As the system tanks get supply from a permanent storage like reservoirs, dams etc. the area irrigated by this -source is classified under canals.

Tanks

The non-system tanks which are fed partly from their independent catchment areas and partly from the diversion of river water and jungle streams depend fully on rain.

Wells

Wells are the principal source of irrigation. During the year under review, open wells and tube-wells/bore-wells continued to be the principal source of irrigation.

Gross Area Irrigated

"Gross area irrigated includes the net area irrigated and the area irrigated more than once".

Irrigation Intensity

"The irrigation intensity (The ratio of gross area irrigated to net area irrigated)"

Cropping Pattern

"Cropping pattern refers to the proportionate area under different crops during a fasli year".

Area and Productivity

"Factors such as fertility of land, monsoon behaviour, rainfall, irrigation, application of fertilizers, climatic conditions, marketing facilities, prices, availability of agricultural labourers etc. determine the area and productivity of any crop".

Marginal Farmers

The land owned by the farmers of below 1.00 hectare.

Small Farmers

The land owned by the farmers of 1.00-2.00 hectare.

Semi- Medium Farmers

The land owned by the farmers of 2.00-4.00 hectare.

Medium Farmers

The land owned by the farmers of 4.00-10.00 hectare.

Large Farmers

The land owned by the farmers of 10.00 hectare and above.

Area

Agricultural area, describes the area already used for farming, or that could be brought back into cultivation using the resources normally available on an agricultural holding.

Production

Agricultural production is the use of cultivated plants or animals to produce products for sustaining or enhancing human life.

Productivity

"Agricultural productivity is measured as the ratio of agricultural outputs to agricultural inputs. This output value may be compared to many different types of inputs such as labour and land (crop yield). These are called partial measures of productivity".

Climate Change

Climate change is a long term change in the statistical distribution of weather patterns over periods of time that range from decades to millions of years. It may be a change in the average weather conditions or a change in the distributions of weather events with respect to an average, for example, greater or fewer extreme events. Climate change may be limited for a specific region, or may occur across the whole earth.

Global Warming

Global warming and climate change are terms for the observed century-scale rise in the average temperature of the Earth's climate system and its related effects. Multiple lines of scientific evidence show that the climate system is warming.

Cultivable Area

Agricultural land is typically land devoted to agriculture, the systematic and controlled use of other forms of life particularly the rearing of livestock and production of crops to produce food for humans. It is generally synonymous with farmland or cropland.

Land holding

A farm is an area of land that is devoted primarily to agricultural processes with the primary objective of producing food and other crops; it is the basic facility in food production.

Monsoon

Monsoon is traditionally defined as a seasonal reversing wind accompanied by corresponding changes in precipitation, but is now used to describe seasonal changes in atmospheric circulation and precipitation associated with the asymmetric heating of land and sea.

Land Use Pattern

Land use pattern involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods. It also has been defined as "the total of arrangements, activities, and inputs that people undertake in a certain land cover type.

Gross Farm Income

Gross farm income refers to the monetary and non-monetary income received by farm operators. Its main components include cash receipts from the sale of farm products, government payments, other farm income, value of food and fuel produced and consumed on the same farm, rental value of farm dwellings, and change in value of year-end inventories of crops and livestock.

Crop Diversification

Crop diversification takes into account the economic returns from different value-added crops. It is different from the concept of multiple cropping or succession planting in which multiple crops are planted in succession over the course of a growing season

3.6. Limitations of the study

Following are the limitation of the study

- The primary data was based on “recall method”. The farmers were not maintaining records on their farm inputs and output details.
- It is a micro level study. Thus the findings of the study may not be applicable for the macro level, and
- All the limitations pertaining to “primary data” are applicable in this study also.