CHAPTER IV

THEORETICAL FRAMEWORK AND RESEARCH DESIGN

4.1 Introduction

This chapter discusses the methods that are used in this research study. Research methodology is vital for any research work that includes research design, data collection, analysis and interpretation of results. The term ‘methodology’ comprises this whole process. The final results of a research depend on the methodology that is employed and it depends on the type of data needed to answer the research questions as in the present study on ‘Ecological and economic implications of change in paddy cultivation, a case study of Palakkad district, Kerala’. The present study addresses spatial and temporal changes in the patterns of paddy cultivation and its ecological and economic impacts. This chapter outlines the theoretical framework, research design, structure and the steps followed in the present research. The methods used in the collection of data, processing, and analysis of data and information used in the research are elaborated, in the following pages.

4.2 Theoretical Framework of the Study

It is evident that no single theory can adequately explain the complex phenomenon of paddy land transformation and its ecological and economic impacts. Therefore, the researcher has relied on two major theoretical frameworks: (1) Development versus Environment; and (2) Agriculture Development versus Environment.

4.2.1 Development Versus Environment
Economic development involves use, abuse and over use of the natural resources like water, air, soil, minerals, forests, and fisheries, embedded within the earth. Developed and industrially advanced countries like the United States, Japan, the United Kingdom, France, Germany and other European countries used, abused and over used their natural resources, including renewable and non-renewable resources for the development of the primary, secondary and tertiary sectors. Therefore, natural resources of these countries have become depleted and degraded to a relatively large extent and now these countries have been implementing stringent, comprehensive and very rigid regulations for the use and conservation of natural resources (Rao 2005). In the past few decades, there was an overwhelming desire amidst the industry to use, abuse and over use natural resources for gaining maximum profits from the precious renewable and non-renewable resources. For instance, mining has played a significant role in the growth of industry but it has also resulted in heavy deforestation and displacement of the poor families from various places. Deforestation induced by mining has led to soil erosion and desertification. In addition, mining has caused water pollution, air pollution, productivity, and health problems like the cancer. Even though, the government is promoting mining, for instance coal mining promoted by the government for the sake of economic progress and growth, resulting in severe environmental degradation in the world. India has faced too many environmental problems due to development projects like dams, special economic zones, electricity, and transportation. For instance, KoelKaro project, the Tehri dam, and Narmada projects, have been causing environmental degradation. One of the most important causes of environmental degradation is anthropogenic (anthropocentric) factors. Anthropogenic development
activities carried out in Himalayas has led to loss of limited and precious ecosystems in the region. Similarly, development projects like road, rail, airport, and the like are causing serious damages to the rural environment (Adiseshiah 1987; Murti 1998).

As far as the study area is concerned, paddy land ecosystems are deteriorating fast due to paddy land conversions. The major causes of paddy land conversion include low profitability, low productivity, low MSP (minimum support price), lack of effective government policies and regulations, ignorance of ecological importance of rice fields, and lack of concern for paddy cultivation in the civil society, and other stakeholders. Paddy lands are converted to non-paddy crops and non-agricultural purposes. Both of these conversions have adverse impacts on the environment. Paddy land conversion for non-agricultural purposes has led to loss of paddy ecosystems and fall of groundwater tables. Market development has on the other stimulated the desire of the farmers to squeeze out profits from paddy lands and their consequent commercialization has led to the loss of a significant amount of the area under paddy cultivation, resulting in serious environmental degradation.

4.1.2 Agricultural Development versus Environment

Increasing population demands the need for more food grains and non-food grains, resulting in an increase in the area under food crops. As a result, there is need for cutting down more trees, deforestation and use of marginal lands, leading to the environmental degradation and loss of biodiversity. Literature relating population growth to agriculture and the environment has been dominated by two schools of thought: the Malthusian and the Boserupian Schools. Malthus argued that population growth required an expansion of agricultural land area in order to feed the population.
Malthus (1798) considered an increase in the land area under cultivation as an alternative response to increased population pressure. Such an increase in land area can occur only in two ways: firstly, clearing more of one’s own land or appropriating neighboring lands; and secondly by migrating to other areas to develop a new land for agricultural purpose by forest clearing, which leads to deforestation. Neo-Malthusians have clearly expanded the approach of Malthus to the present-day environmental concerns by asserting that an expansion of agricultural area (agricultural extensification) must come from forests and other vegetated lands and therefore must require deforestation leading to environmental degradation (Carr, Lopez et al. 2009; Rao, 1994).

Boserup (1965) has challenged the Ricardian-Malthusian assumption of the technology constant, population growth and agricultural conceptualizations, and postulated that as population grows land becomes a scarce resource and is therefore used more intensively, resulting in agricultural intensification. In other words, Boserup (1965) brought in an optimistic view and argued the positive impact of increasing population growth/density inducing agricultural innovations that would increase output to restore food production per capita, and avert a decline in standard of living, without necessarily increasing agricultural land area or reducing forest cover (Carr.et.al.,2009).

Agricultural innovations could take place even without population growth. For example, scarcity of labour leads to innovations in agricultural sector and hence, agricultural intensification is associated not only with population growth, as emphasized by Boserup (1965) but also with other factors like the scarcity of labour that leads to agricultural and technological innovations. Whatever the reason for agricultural intensification, it leads to possible decrease in soil quality, yields, salinization, water
contamination, aquifer mining, and environmental degradation (Bilsborrow et al. 1992; Bilsborrow 2002). Agricultural development in terms of agricultural extensification and agricultural intensification leads to the rural environmental degradation. Agricultural extensification needs deforestation and agricultural intensification needs more chemical fertilizers, pesticides, machines, HYV seeds, intensive irrigation, and energy. So, agricultural extensification by deforestation and agricultural intensification by chemical fertilizers application leads to irreversible damages to the environment. From this, it is concluded that agricultural development eventually leads to a total destruction of the environment and ecology.

4.3 Research Questions

This research investigates into ecological and economic implications of decline in paddy area in Palakkad district. The major research questions of the study are:

1. What are the trends and patterns of paddy land conversion in Palakkad district?
2. What are the major reasons of paddy land conversion in the study area?
3. What are the ecological impacts of paddy land conversion in the study area?
4. What are the factors responsible for the production, income and profitability?
5. What is the impact of paddy land transformation on the livelihood security of the farmers in the study area?

4.4 Selecting an Appropriate Methodology
Selecting an appropriate methodology for specific research depends on the research objectives and research questions which are answered through research. The research methods must lead to comprehensive and clear results at the end of the research.

4.4.1 Methodology Used in the Study

The methodology used in the study is an integrated methodology, where traditional data collection and processing is integrated with the modern, statistical analysis and using GIS and Remote Sensing Applications. Most research studies have the following components:

- Primary sources of data;
- Secondary sources of data;
- Remote sensing and GIS as tools and applications;
- Statistical and other measuring techniques; and
- Library research.

Two types of data could be collected, primary and secondary data. Primary data are recognized as data that are gathered for a specific research in response to a particular problem through interviews, questionnaires or observations whereas the secondary data can be obtained from various kinds of documents such as research reports, annual reports, books, and articles (Schensul, Schensul, and LeCompte 1999). In this study, both primary and secondary data are used for the empirical analysis.

4.5 The Research Design

Research design serves as a logical manual to guide a researcher in the course of data collection, analysis and interpretation. Stating clearly each step in the manual can
help a researcher collect the right kind of data and analyze them in the right way to address the primary research questions. A survey is often classified by the kind of instruments used. There are many methods of collecting data such as observations, interviews or questionnaire survey. Lewis and others (2000) note that the greatest use of questionnaires is made by the survey strategy. Questionnaires can therefore be used for descriptive research such as that undertaken using attitude and opinion questionnaires and questionnaires of organizational practices enable us to identify and describe the variability in different phenomena (Lewis, Saunders, and Thornhill 2009).

According to Lewis (2009), there are six different sources for data collection: documentation, archival records, interviews, direct observations, participant observations and physical artifacts. All of these sources of evidence have both strengths and weaknesses, but none is considered superior to the other. Creswell (1994), therefore, recommends using several of them while a good research should thereby include as many sources as possible. Case study is an ideal methodology when a holistic, in-depth investigation is needed and also has identified some specific types of case studies: exploratory, explanatory and descriptive and includes three others: intrinsic - when the researcher has an interest in the case; instrumental - when the case is used to understand more than what is obvious to the observer; and collective - when a group of cases is studied.

Triangulation is the application and combination of several research methodologies in the study of the same phenomena. It can be employed with quantitative and qualitative studies. At the present, triangulation method is used by most social science researchers to achieve better results from their research work. By combining
multiple theories, empirical materials and research methods, the researchers can overcome the weaknesses or biases that come from a single method. Combination of two methodologies may also increase reliability and present a more accurate picture of the problem. Creswell (1994) stresses that the concept of triangulation was based on the assumption that any bias inherent in particular data sources, investigators, and methods would be neutralized when used in conjunction with other data sources, investigators, and methods. He further describes that a combined method of study is one in which the researcher uses multiple methods of data collection and analysis and also these methods might be drawn from ‘within methods’ approaches, such as different types of quantitative and qualitative data collection strategies.

### 4.5.1 Field Reconnaissance

Prior to setting up the research design, a reconnaissance of the field must be done. This has indeed been made in the present study in order to gather some materials for developing a methodology that could be used in the study. The reconnaissance has also been made for the purpose of making observations of the current situation in the study area, besides speaking to some concerned authorities, institutional personnel and government officials on the nature and characteristics of paddy cultivation in Palakkad district. The scholar has extensively travelled and interacted with the concerned agricultural officials in the study area. Reconnaissance has been in the early part of this research and has come in useful in meeting officials who could help with certain insights in writing up the thesis as well.

### 4.5.2 A Framework for Methodology
A framework for methodology of the study has been developed to describe the relationships between various elements of the methodology for the study of the major cropping patterns and socio-economic development and the framework for analysis, showing the entire methodology adopted for the study (Figure 4.1)

4.5.3 Primary Source of Data

This study is on “Paddy Land Transformation and Its Impact on Ecology and Economy of Palakkad District” in Kerala. Therefore, the researcher has taken the paddy farmers in Palakkad as the Universe for his sample population. Data on the socio-economic conditions of the paddy farmers is not available from secondary sources. So, the study is in the form of primary survey research, that is, data have been generated using the primary survey to assess socio-economic conditions of the paddy farmers in the study area. A semi-structured, pre-tested schedule has been prepared (Appendix 4.1) for soliciting the socio-economic data of the paddy farmers in the study area. A total sample of 720 farmers (respondents) has been taken. The samples are distributed across the study area, that is, Palakkad district. The details of the sample selection are provided in the next section. Qualitative research methodology has been used as a mode of inquiry for the study. An in-depth interview of the paddy farmers has been conducted using the standardized, open-ended interview method. That is, asking specific questions in a specific sequence to get the farmers’ correct experiences and views on the paddy farming. The sample farmers are from the pool of marginal, small, medium and large farmers and as such are stratified random in the selection.

4.5.4 Sample Methods
Sampling considerations pervade all aspects of research and crop up in various forms no matter what research strategy or investigatory technique we use. Creswell (1994) argues that it is unusual to be able to deal with the whole of a population in a survey, which is where sampling comes in: "a sample is a selection from the population". Particular attention needs to be given to the selection of the 'people sample' in planning a survey. In quantitative methods, it is acceptable for researchers to use either probability or non-probability sampling (Creswell 1994; Lewis, 2009). According to Creswell (2002), in non-probability samples, you cannot make statistical inferences; however, it may still be possible to say something sensible about the population from non-probability samples. Creswell (1994) suggests that it is not always possible to use probability sampling in social science research; instead a researcher can use non-probability sampling, where the researcher selects individuals because they are available, convenient, and represent some characteristics the investigator seeks to study. This study has employed therefore a non-probability sampling.

Sample paddy farmers have been selected through mixed methods (MM) sampling: stratified, purposive and random sampling methods from the 13 blocks of Palakkad district in Kerala. Group discussions have been conducted with the paddy farmers in order to understand the views of paddy farmers on the problems faced by them in the paddy fields, and to know costs and benefits of paddy cultivation, socio-economic conditions, food security and the environmental issues in the study area.

On the basis of the availability of paddy farmers, the blocks in Palakkad district have been divided into three groups of paddy farmers’ concentrations: high, medium and
low. That is, those blocks with a large number of paddy farmers (that is, more than 8,000 paddy farmers) is known as high concentration zone, medium zone means that the block shave between 4,000 and 8,000 paddy farmers and low zone means that the blocks have less than 4,000 paddy farmers. There are six blocks which are a high concentration zone of the paddy farmers; four blocks that are a medium concentration zone; and 3 blocks that are a low concentration zone. According to Teddlie et al. (2009), the researcher needs 384 samples in order to estimate the characteristics of population as per Table 4.1, when the total population of paddy farmers is 92,997 (2014 - 2015). But, the researcher has collected 720 samples from the paddy farmers. To get 720 samples from the study area, the researcher has selected 60 farmers each from 6 high concentrating blocks (6 x 60 = 360), 50 farmers from medium (5 x 50 = 200), and 40 farmers each from low block (3 x 40 = 120). From the 13 blocks 680 respondents were selected as the samples for the present investigation. Forty samples have been additionally chosen from the four municipalities of the district, with 10 each to a municipality (4 x 10 = 40 farmers). For the purpose of the study, the municipalities have all been considered as a single unit. A total of 720 (360 + 200 + 120 + 40) samples have been collected through a random and purposive process. The distribution of samples in different blocks and municipalities of the study area is shown in Table 4.2 and Figure 4.2. The questionnaire survey data have been collected during the Mundakan and Virippu seasons of the year 2014-15. During the time of selecting sample paddy farmers for the study, the several dimensions of paddy farming and farmers have been taken into the account by the researcher such as the size of farmer, location, and economic conditions. Note:

Population size confident that the sample estimates of population within (+/ - 1%)

Confident that the sample estimates population within (+/ - 5%)
Table 4.1: Relationship between Sample and Population Sizes Using Probability Sampling Techniques

<table>
<thead>
<tr>
<th>Population</th>
<th>(+/- 1%)</th>
<th>(+/- 5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>99</td>
<td>80</td>
</tr>
<tr>
<td>500</td>
<td>476</td>
<td>218</td>
</tr>
<tr>
<td>1000</td>
<td>906</td>
<td>278</td>
</tr>
<tr>
<td>2000</td>
<td>1,656</td>
<td>323</td>
</tr>
<tr>
<td>3000</td>
<td>2,286</td>
<td>341</td>
</tr>
<tr>
<td>Infinity</td>
<td>9,604</td>
<td>384</td>
</tr>
</tbody>
</table>


Table 4.2: Sample Selection of Paddy Farmers, Palakkad District

<table>
<thead>
<tr>
<th>SL.No.</th>
<th>Name of Block</th>
<th>Concentration of Paddy Farmers</th>
<th>No. of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alathur</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Kuzhalmannam</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Chittur</td>
<td>Blocks having above 8,000 Paddy farmers (High concentration)</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Nenmara</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Kollengode</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Ottappalm</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>360</strong></td>
</tr>
<tr>
<td>B</td>
<td>Palakkad</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Malampuzha</td>
<td>Blocks having Paddy farmers between 4,000 and 8,000 (Medium concentration)</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Sreekrishnapuram</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Pattambi</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>200</strong></td>
</tr>
</tbody>
</table>
### C

<table>
<thead>
<tr>
<th>Block/Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mannarkkad</td>
<td>40</td>
</tr>
<tr>
<td>Thrithala</td>
<td>40</td>
</tr>
<tr>
<td>Attappady</td>
<td>40</td>
</tr>
<tr>
<td>Municipalities</td>
<td>40</td>
</tr>
</tbody>
</table>

#### D

<table>
<thead>
<tr>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>160</td>
</tr>
</tbody>
</table>

#### E

| Grand Total (A+B+C = D)      | 720   |

### 4.5.5 Paddy Farmers Questionnaire

Since the study has been designed to examine primarily data from the official sources, a full-fledged survey of the farmers has not been the intention of the questionnaire survey. Hence, only a simple questionnaire of 4 major sections has been custom-designed. In all, there are 73 questions, seeking relevant information on land holdings, major crops and farm incomes and also some information on the livestock and household assets of the farming households. The section headings of the questionnaire and the number of questions under each of them are:

- **A: Personal Particulars (12 Questions)**
- **B: Socio-Economic Particulars (8 Questions)**
- **C: Agricultural Crops with special reference to paddy cultivation (29 Questions)**
- **D: Causes of paddy area decline, Suggestions, Strengths, Weaknesses and Recommendations (24 Questions)**

**Personal Particulars**: The section on personal and household particulars has been intended to gain personal information on the farmer-respondents, namely, her/his name, sex, age, educational attainment, occupation, type of agriculture, category of the farmer, other employment category, and the nature of land ownership. Educational
attainment, occupation (the information sought for is on agricultural and/or non-agricultural occupations such as businesses, self-employment, and others). The information sought on the type of agriculture is by way of knowing what type of agriculture the farmer-respondent is involved in: dry or irrigated agriculture or both. The next information sought is on the category of farmer the respondent is: marginal, small, semi-medium, medium and large.

Socio-Economic Particulars: First, the researcher seeks information on the agricultural land holdings of the paddy fields of the farmer-respondent. The next set of information sought after in the study from the farmer-respondent is that of livestock. Information on household assets has also been sought after through the questionnaire towards understanding the socio-economic status of the farming households. Here, the scholar has sought data on the level of agricultural infrastructures as well as household amenities, to make out how they have progressed in their economic life.

Agricultural Crops: Only two pieces of information are sought in this section from the farmers to know of the major crops in 1973 and 2013 and also the farm incomes in the two years of our concern. This is thus entirely a recall set of data. Productivity, production, cost of production, net income of paddy as well as other crops are also sought after from the farmers. In obtaining this information on farm incomes, the scholar has intended to be as unobtrusive as possible. The scholar has used his knowledge of the area and its agriculture in listing the major crops (he lives in the district, and teaches geography at a local college).

Causes, Suggestions and Recommendations: In this section, the questionnaire seeks suggestions for improving the farming in the panchayaths, the strengths and
weaknesses of paddy cultivation in their villages and also recommendations they would like to make in regard to paddy cultivation. As a final shot of the questions, the scholar has sought answers from the farmer-respondents on the question: ‘any other comments’ the farmers may wish to make as a signing off, of the interview with the scholar.

The questionnaire designed is thus of ideal length for the farmers, for they are all the time busy and engaged in various activities and the clocked time for interview is 34 minutes.

**Questionnaire Surveys and Interviews**

The questionnaire surveys and interviews have been held face-to-face, in free associational mode, and by administering the questionnaires in the regional language (Malayalam).

**4.6 Methods Adopted for Empirical Analysis**

**4.6.1 Spatial and temporal analysis of decline in paddy lands and its impact on ecology**

Paddy fields of Palakkad district have been delineated using the Survey of India Topographical map series (No: 58A/8, 58A/12, 58A/16, 58B/1, 58B/5, 58B/6, 58B/7, 58B/8, 58B/9, 58B/10, 58B/12, 58B/13, 58B/14, 58B/15, 58B/16) of scale 1: 50,000. Past agricultural land use details of Palakkad district (1973 -1974) and cropping patterns of paddy fields have also been identified from the topographical sheets. Multi-temporal satellite data sets of LANDSAT 5 (Thematic Mapper (TM), LANDSAT 4 and Multi- Spectral Scanner (MSS) have been used for analyzing the present (2012) agricultural scenario. The satellite digital data have been rectified using Survey of India (SOI) topographical maps; a reconnaissance survey has been carried out to collect the
ground truth information. The GIS database generated from the topographical sheets has further been updated with the latest changes in Palakkad district. The field experience and information have been employed to perform the classifications based on digital landuse/land cover classification through supervised classification methods. The image elements have also been correlated with ground truth verification and the interpretation keys have been then developed. Base maps including roads, railways, settlements, village locations and watershed boundaries have been extracted from the topographical sheets. Physical details of Palakkad district such as the physiography, watershed, drainage, slope and DEM have been extracted from the topographical sheets. Soil details of Palakkad district have been gathered from the District Soil Survey Department. Geology and geomorphology details have been collected from the Geological Survey of India, TVM.

Arc GIS 10.0, ERDAS 8.6 and Arc Map have been used in the preparation of the thematic maps. The classification has been performed based on the classification scheme of the National Remote Sensing Center (NRSC), Department of Space and Government of India. The secondary data have been collected from Agricultural, Economics and Statistics Department of the Government of Kerala at Palakkad.

- Block level and panchayath level changes and transformation in paddy cultivation have been identified using overlay – intersection and land use matrix methods using a GIS Platform.
- Decline in paddy areas in different geographical units have been estimated using overlay – intersection land use matrix method using a GIS Platform.
- Rate of change in paddy lands (decline proper) has been computed using the following formula of Compound Annual Growth Rate.
\[ CAGR(t_0, t_n) = \left( \frac{V(t_n)}{V(t_0)} \right)^{\frac{1}{t_n-t_0}} - 1 \]

Where

\[ V(t_0) \quad \text{: Start value}, \quad V(t_n) \quad \text{: finish value}, \quad t_n - t_0 \quad \text{: number of years.} \]

- Projection of paddy lands decline is carried out using the regression formula of

\[
Y = a + bX
\]

\[
b = \frac{N\sum XY - (\sum X)(\sum Y)}{N\sum X^2 - (\sum X)^2} \quad a = \frac{\sum Y - b\sum X}{N}
\]

- **Food Security Analysis:** The requirement of food either in weight or calories varies according to age, sex, occupation, body size, income, culture and climate. According to Singh’s scale (1970), each unit of the population is equal to 0.773 consumption unit or 1,000 persons are equal to 773 consumption units. These are the triennium average of the total projected population of each ward that has been calculated and is multiplied with the co-efficient of consumption (773) in order to get the consumption unit of the total population. Food availability has been worked out at the block and municipal levels by taking triennium average data of agricultural produce of the year. There are many sources of leakages; for example, losses in transport and storage, destruction by insects and pests, kitchen waste, and use of seeds between the production and consumption of agricultural produce, but the precise data for all these aspects are not available. Therefore, Chakravarthy (1970), after examining various estimates of losses and accounts given by different scholars and institutions has suggested the standard deduction of 10 percent exclusive of real requirement. Similarly, after evaluating various estimates of seed requirements ranging from 3.5 percent to 14.0 percent, Chakravarthy has recommended 6.8 percent of the total production for seed requirements. Hence, the total deduction of wastage, cattle feed and seed ought to be 16.8 percent of the total gross production. The co-efficient of production is therefore 0.
832 (100-16.8 = 83.2) (Chakravarty 1970). This formula has been used for calculating total amount of energy available from total rice production of particular area. For the present analysis, however, 350 grams/ day of rice is considered as an ideal amount for getting sufficient energy for leading a healthy life in Kerala conditions, which is equivalent to 4,581,250 kcal/year. Kannan (1995), in his paper on ‘Public Intervention and Poverty Alleviation’ has revealed that there is successive decrease in the areal extension of paddy areas as well as rice production. According to Stamp (1962), 450 grams/ day of cereals per head is required of a man for maintaining subsistence life and it is 2,460 kcal/day, which is equivalent to 900,000 kcal/year and it is termed as standard nutritional unit (SNU), which is the required energy for an average man per day: carbohydrate is 1,250 to 1,300 kcal, that is, 300 to 400 grams of rice is needed for leading a sustained life per day.

Simple statistics with Microsoft Excel is utilized as platform for the tabulation and further detailed analysis. For the purpose of description of sample and respondent related characteristics, a frequency and percentage analysis is done for all variables extracted from the farmers’ survey using the questionnaire and put into datasets. A simple frequency of each of the fields with column percentages is made and then some two-way tables using certain select pairs of variables are carried out, in order to measure variations, both temporal and spatial. The scholar has also explored the data by measuring the central tendencies of the data, and more importantly, the dispersion of the data around the central tendency.

**Groundwater Recharge:** Hydrological data on paddy fields in the Karrimpuzha watershed (water requirement, evapotranspiration, infiltration) have been collected from
the Hydrology Division, Rice Research Institute, Pattambi, Palakkad district, Kerala. Water balance model of paddy per ha has been calculated based on the formula:

\[ IRS = RSW - (RCWD + EPTL + IFL) \]


The collected data have been analyzed with the help of proper statistical techniques and tools.

**Floristic Threat:** The floristic biodiversity of the paddy fields has been enumerated in a multiphased manner. Plant specimens have been collected both in the summer and in the rainy season. In each season, the floristic character of the study area has been analyzed in the pre-harvest and post-harvest periods. Plant specimens have been collected by conventional method and mounted on herbarium sheets. Collected specimens have then been identified with the help of the floras like the Flora of Presidency of Madras (Gample and Fischer 1915), Flora of Palaghat District including Silent Valley National Park, Kerala (Vajravelu 1990), Flora of British India (Hooker 1879) and Flowering Plants of Thrissur Forests: Western Ghats (Sasidharan and Sivarajan 1996). The arrangement of plants are based on Bentham and Hooker’s (Bentham et al. 1883) system of classification.

**Livelihood Threat:** In-depth interviews and focus group discussions (FGD) have helped the researcher much in understanding the problems faced by the paddy farmers and influence of paddy cultivation on the rural poor. These data have been used for analyzing the role of paddy cultivation on the rural poor of Karrimpuzha watershed.
• These primary data are used for evaluating the negative effects of decline in paddy area and cultivation on the livelihood of the rural poor.

• The statistical tools like the measures of central tendency (mean, median and mode), rate of change, and factor analysis have been used.

4.6.2 Economic Impacts of Decline in Paddy Land, Causes of Paddy Land Conversion and Implications

Socio-economic details of paddy farmers - Primary data collection: The primary survey has been conducted using a semi-structured schedule. Such schedule has been developed after reviewing various studies and research papers on paddy cultivation and also after a series of discussion with the experts, scientists and others who are closely associated with paddy cultivation. In January 2014-15, a pilot survey has been conducted in Palakkad district to understand the strengths and limitations of the schedule and since then the schedule has been modified in a way it is suitable for the study. As many as 720 samples have been interviewed during the Virippu and Mundakan seasons of the year 2014-15. Virippu (Autumn) is the first crop (July-September) and Mundakan (Winter) is the second crop (October-January), and Puncha (Summer) is the third crop (February-April). Therefore, the researcher has conducted primary survey among the paddy farmers in the study area during the period of July 2014 –January 2015. In-depth interviews with the paddy farmers and group discussions with the paddy farmers and other stakeholders (the Officers of Department of Agriculture, Rice mill owners) have been carried out during the period as well. In-depth interviews and focus group discussion (FGD) have helped the scholar much in understanding the problems faced by the paddy farmers, ecological importance of the paddy fields and the livelihoods of
paddy farmers in the study area. Irregular rainfall and other climatic shocks (rising temperature and drought) are the events that affected the paddy farmers the worst in the study area.

- The primary data are used for addressing the nature and characteristics of paddy farmers and their socio-economic status.

**Economic impacts of decline in paddy lands: Net return and cost benefit ratio of paddy cultivation:** Net returns approach has been used to examine the economics of paddy cultivation and the alternate crops. Net income is found after deducting all expenditures incurred-actual as well as imputed- for farm production from the gross value of farm output. This helps in measuring the efficiency of different farms in the region or in different regions or of the same farm at different points in time. The concept of cost has been developed in various farm management studies and it is often followed as model for estimation of cost of cultivation of crops. These concepts have been used in a number of studies in Kerala for cost estimation. For estimating cost of production of paddy and the alternate crops in Palakkad district, we have also followed the concepts of costs used in the farm management studies, with some minor modifications. Four different cost concepts have been followed in these studies. They are defined as follows:

- **Cost A, variable cost** = hired human labour, seed, machinery hire, chemical fertilizers, pesticides and manures (both farm produced and purchased).

- **Cost B, fixed cost** = irrigation charges, land revenue tax, depreciation of implements and other implement charges.

- **Cost C, total cost** = Cost A + Cost B
On the basis of these costs, net income may be defined as gross income minus cost C. As there exists no tenancy in the sample farms, rent (both paid out and imputed one) has not been taken into account in the estimation of cost. The total cost is divided into two: the variable cost and fixed cost. The important items of expenditure considered for variable cost estimation are those for human labour, machinery hire, seed, irrigation, fertilizers, pesticides and transportation. The items of expenditure included under fixed cost are those for interest on working capital, land revenue tax and depreciation. Two concepts of income, namely, Gross Income and Net Income have been used to examine the returns from paddy cultivation in the study area. Gross Income is defined as the value of paddy and straw. Likewise, the value of the output of alternate crops and their byproducts if any is defined as Gross Income. The difference between the Gross Income and total cost of production indicates the Net Income. Further, an attempt is also made to work out the benefit-cost ratio of not only paddy and the alternate crops but also for different farm size groups of the crops. This is worked out by dividing Gross Income with total Cost of Production.

**Cause of Decline in Paddy Area:** This research has used both primary and secondary sources of data to find the reasons for decline in the area of cultivation of the study area over space and time. The first-hand information of causes of decline in paddy area has been collected using a semi-structured schedule, in-depth interviews and focus group discussions with the paddy farmers and other stakeholders in the study area in Palakkad district. Secondary sources of information are from the various issues of Economic Review, Census Reports, Agricultural Statistics, District Handbooks of Palakkad, Farm Guides, and Panchayath Development Reports. In addition to this,
relevant materials and statistics from various others published and unpublished documents of the Government and NGOs (non-governmental organizations) and academic institutions; academic journals, magazines, newspapers, and seminar proceedings have also been used. Websites, e-magazines, and e-journals have also been used as secondary sources of information in the study.

- Data collected from various sources (primary and secondary) are classified and organized using EXCEL and SPSS 16 (Statistical Package for Social Sciences) software. For analyzing and interpreting data, simple cross tables, graphs and diagrams have been used. The statistical tools like the measures of central tendency (mean, median and mode), rate of change, and factor analysis have been used. Depending upon the research questions and research requirements other statistical tools are also used in the study.

4.6.3 Conclusions and Recommendations

The final chapter of the thesis, titled ‘Conclusion and Recommendations’ discusses the various dimensions of paddy land conversion strategies. Economic implications of the study reveals that cost factor, especially labour wage rate is the critical issue of low economic return of paddy cultivation and land conversion. Hence, for the sustainability of paddy fields and to overcome the issues of cost factor, a simple economic model has been developed.

- A Simple Model of MGNREGS Intervention for the Sustainability of Paddy Cultivation using producer behaviour and producer equilibrium concept.
4.7 Library Research

In setting up the research design, detailed library research relating to the research topic must be done. This has indeed been made in the present study in order to collect information for constructing the methodology and writing the review. The scholar has extensively used library facilities at the Department of Geography, Kannur University, Government College Chittur, Calicut University, University College Thiruvanthapuram, Madurai Kamaraj University, Tamil Nadu Agriculture University, Kerala Agriculture University, Rice Research Institute at Pattambi and Agriculture Engineering College, Thavanoor, Malappuram. Research articles, magazines, economic reviews, farm guides, economics and statistical reports, census reports have also been utilized for the research work. Besides, internet has been used, very extensively for data, documents and research papers accessible from journals of repute from different countries and most importantly satellite images for assembling of ideas for the thesis.

4.8 Conclusion

This chapter on Research Methodology has formed a bridge between the theoretical and empirical aspects of the study and the chapter has explained the methodology adopted in the study and its rationale and relevance, particularly the questionnaire survey conducted with the farmers of the district towards understanding the nature and characteristics of the paddy farmers, the cropping patterns over time and space, ecological and economic impacts of decline in paddy lands due to conversion to other crop and land uses and the socio-economics affected through agriculture. This chapter has comprehensively dealt with the five major components of the methodology.
• Theoretical frameworks of the present research work has been designed using two theories, that is, environment versus development and agriculture versus development.

• In the past few decades, the abuse and overuse of natural resources have been made for gaining maximum profits from the precious renewable and non-renewable resources over the earth surface.

• Increasing population has demanded the need for more food grains, resulting in an increase in the area under food crops. As a result, there has been a need for cutting down more trees, deforestation, and use of marginal lands, leading to environmental degradation and loss of biodiversity. As far as the study area is concerned, paddy land ecosystems have been deteriorating fast due to paddy land conversion to other land use systems in the name of development. From this, it has been concluded that agricultural development eventually has led to almost total destruction of environment and ecology.

• Malthus, Boserup, and Ricardo have been the eminent scholars who have first put their views about the issues of population pressure on natural resources and have also addressed the negative relationships between development and environmental quality.

• An integrated methodology has been adapted in the present research work, where traditional data collection and processing have been integrated with the modern, statistical analysis and GIS and Remote Sensing Applications.

• In this study, both primary and secondary data have been used for the empirical analysis. Primary data have been recognized as data that are gathered for a
specific research in response to a particular problem through interviews, questionnaires and observations whereas the secondary data can be obtained from various documents such as research reports, annual reports, books, and articles.

- Sample paddy farmers have been selected through mixed methods sampling: stratified, purposive and random sampling methods from the 13 blocks of Palakkad district in Kerala. Group discussions have been conducted with the paddy farmers in order to understand the views of paddy farmers on the problems faced by them in the paddy fields, and to know costs and benefits of paddy cultivation, socio-economic conditions, food security and the environmental issues in the study area.

- On the basis of the availability of paddy farmers, the blocks in Palakkad district have been divided into three categories of paddy farmer-concentrations: high, medium and low. There are six blocks which are a high concentration zone of the paddy farmers; four blocks that are a medium concentration zone; and 3 blocks that are a low concentration zone. When the total population of paddy farmers is 92,997 in Palakkad district (2014 - 2015) and the researcher has chosen 720 samples from the paddy farmers.

- Paddy fields of Palakkad district have been delineated using the Survey of India Topographical map series of scale 1: 50,000. Past agricultural land use details of Palakkad district (1973 -1974) and cropping patterns of paddy fields have also been identified from the topographical sheets. Multi-temporal satellite data sets of LANDSAT 5 (Thematic Mapper (TM), LANDSAT 4 and Multi- Spectral
Scanner (MSS)) have been used for analyzing the present (2012) agricultural paddy lands scenario. Decline in paddy areas by blocks and different geographical units have been estimated using overlay – intersection land use matrix method using a GIS Platform (Arc GIS 10.0).

- Food security has been analyzed using the combined methodologies of L.D Stamp (1962), Singh (1970), Chakravarthy (1970) and Mohammed Shafi (1980). Water balance model of paddy per ha has been calculated based on the formula: $\text{IRS} = \text{RSW} - (\text{RCWD} + \text{EPTL} + \text{IFL})$, ($\text{RSW} – \text{Required Standing Water at Paddy fields, RCWD – Required Crop Water Requirement, IFL – Infiltration loss, EPTL – Evapotranspiration Loss, IRS – Irrigation Supply}$).

- The floristic biodiversity of the paddy fields has been enumerated in a multi-phased manner. Plant specimens have been collected both in the summer and in the rainy season. In each season, the floristic character of the study area has been analyzed in the pre-harvest and post-harvest periods. Plant specimens have been collected by conventional method and mounted on herbarium sheets.

- Economic impacts of paddy land conversion; agriculture practices and socio economic conditions of paddy farmers and causes of paddy land conversion have been gathered using primary survey. The primary survey has been conducted using a semi-structured schedule. Such schedule has been developed after reviewing various studies and research papers on paddy cultivation and also after a series of discussion with the experts, scientists and stakeholders who are closely associated with paddy cultivation. In January 2013-14, a pilot survey was conducted in Palakkad district to understand the strengths and limitations of the
schedule and since then the schedule was modified in a way it is suitable for the study. As many as 720 samples have been interviewed during the Virippu and Mundakan seasons of the year 2014-15. Virippu (Autumn) is the first crop (July-September) and Mundakan (Winter) is the second crop (October-January), and Puncha (Summer) is the third crop (February-April). In-depth interviews and focus group discussions (FGD) have helped the researcher much in understanding the problems faced by the paddy farmers and influence of paddy cultivation on the rural poor.

In the next two chapters, the scholar is attempting an interpretation of the results of various analyses made using different and good sets of data for understanding the problem better and in an incisive manner.