CHAPTER 3
OBJECTIVE, SCOPE, AND METHODOLOGY

3.1 INTRODUCTION
Evaluation of Cleaner Production (CP) in an industry is crucial especially in Micro, Small and Medium Enterprises (MSMEs) as observed in the literature review. It was clear beyond doubt from the available literature that adoption of CP is helpful for the industries not only from the environmental perspective but also more importantly from the economic perspective. The latter perspective is more appealing for industries in a developing country like India. This prompted the current study to inquire the CP status in MSMEs and furthering these efforts in investigating opportunities and benefits in agro based industrial sector. In consultation with the subject experts, academicians and industrial entrepreneurs, the objectives, scope and methodology of the study was formulated. This chapter presents a research framework of the proposed study followed by discussion of the objectives, scope, questionnaire design, and data collection procedure. The methodology adopted to explore the hidden features of the sector that would be supporting or hindering the adoption of CP strategy is also briefed.

3.2 THE RESEARCH FRAMEWORK
There is ample number of examples about the CP study in various industries throughout the world. Majority of them are demonstration projects intended to prove the worthiness of the strategy. There are clear evidences that adoption of CP strategy will enhance the environmental performance. This might be through a sophisticated approach of adopting cleaner technology or through a set of measures which are relatively not so complex. The second option comprises altering the process and adopting energy conservation measures or simple inexpensive housekeeping practices. However, the assessment of CP level has not been standardized due to the variability in the processes. It is evident that adoption of CP in agro-based MSMEs can be enhanced rapidly by appreciating its benefits and by recognizing opportunities that this industry sector poses. In this backdrop, a research framework has been developed to outline path of the current research and its deliverables as shown in the figure 3.1. It has been conceptualized that opportunities and benefits of this strategy in the considered sector can be understood holistically by studying various stages of production process, energy consumption patterns, environmental impact caused,
prevailing level of CP, existing potential for CP adoption, and barriers & drivers in realizing the CP potential.

Figure 3.1: Research Framework

This research focuses on identifying the opportunities for CP in the agro-based industry sector. A thorough understanding of the production process being adopted in these industries and the resulting environmental impact assessment gives an indication of appropriateness of the existing processing practices. Nevertheless, to express the potential for improvement in CP quantitatively, benchmarking the industrial units based on CP will be carried out. Benchmarking gives the relative performance of an industrial unit and improvement potential possible when compared to best performing unit in the surveyed sample representing the cluster. Mere understanding of the improvement potential is not sufficient to increase the CP performance, as it depends on multiple factors. Identification of the factors influencing CP performance in agro-based industries would help in
implementing it. Thus, factors which contribute to CP are identified and used for the assessment of its level. The variation in the performance level in similar processing units is assessed by identifying and analysing the influence of other factors which are not used in the CP assessment. Finally, the barriers and drivers to implementation of CP in agro-based industries are identified and analysed to assist in fine tuning the MSME policy.

3.3 OBJECTIVES OF THE STUDY
The literature survey illustrated the various initiatives to practice CP, but it is important to observe that there are differences in the adoption of CP in various regions of the world. In some regions CP is already integrated into national policy and regulatory framework, while in other regions it is still in its infancy. Keeping this in mind, this study intends to undertake an empirical research in the Indian context to probe the opportunities and benefits of CP in detail. The main objective of the study is realised through a thorough understanding of the prevailing production processes apart from the energy and environmental issues which are closely associated with CP. The CP issues pertaining MSMEs in the agro-based industrial sector is considered. For accomplishment of the overall goal of this research the following specific objectives are set.

1. To study the production processes in the three selected agro based MSME clusters.
2. To understand energy consumption patterns and to estimate environmental impact of the existing production processes.
3. To assess the prevailing CP level and to probe the factors influencing CP.
4. To assess the CP performance and explore the potential for CP practices.
5. To identify and analyse the drivers and barriers for CP initiatives.

3.4 SCOPE, SAMPLING, AND DATA COLLECTION
The state of CP strategy in large scale industries is robust as compared with the MSMEs. Larger industries have realised end-of-pipe solutions are not beneficial in the long run. It is also true that large industries have all the institutional support and expertise in implementing any new strategy including CP. But MSMEs lack this aspect and they have developed a notion that these types of strategies only benefit large industries. Another misconception in the MSME sector is since they consume less resource and pollute less at the individual unit level, adoption of strategies like CP is not useful and economical for them. To popularise the approaches like CP in MSMEs, a thorough understanding of its
opportunities and benefits becomes a pre-requisite. It is exactly in this context that the current empirical research is undertaken. However, owing to the constraints of time and resource the scope of research is restricted to agro-based industrial sector.

3.4.1 Scope of the Study

Agro-based industries process the agriculture output and mostly they operate in small scale industrial sector, naturally located in rural areas. In developing countries, agro-based industries are playing very important role in rural poverty alleviation and employment generation apart from earning foreign exchange. The context of the present study is illustrated in figure 3.2.

![Diagram](image)

Figure 3.2: Context of the Study

Agro based MSME units in the three products belonging to food and beverages sector is selected for the study. The three products in the food and beverages sector are also carefully chosen to assure they represent three different types of food goods viz.

a. Basic food goods (Rice mills)

b. Intermediate food goods (Cashew processing)

c. Consumer food goods (Bakeries)
Rice mill process provides the rice that is ready to cook is a basic food product whereas bakery products are ready to consume food items that constitutes consumer product. Cashew processing provides the edible cashew kernels which can be consumed readily but traditionally they are used in making bakery and confectionery food items and can be regarded as intermediate product.

The characteristics of the three selected industries is that they consumes agriculture output as their raw material and produces ready to consume or partially ready to consume food. They require several resources for the processing including energy and water. Energy may be in the form of electrical, thermal, or mechanical apart from labour energy. These industries generate pollutants mainly due to the use of fuel/energy and water for processing. The pollution load from individual units may be small but the collective pollution at the cluster level is of serious concern. They also generate by-products of value which are to be utilized judiciously.

The geographical locations of the clusters of the three agro based industries selected for the current study are presented in figure 3.3. The primary data required for research in all the three MSME clusters of this study is collected from the industrial units situated in the respective clusters in Karnataka, a southern Indian state. Bakeries are spread along the residential zone throughout Karnataka State; cashew processing industries are located in coastal Karnataka i.e. in Dakshina Kannada, Udupi and Uttara Kannada districts and rice mills are densely situated in the Koppal, Raichur, Tumkur and Shimoga districts. In this research study, data is collected from the bakeries situated in the Shimoga district as bakery processing practice throughout Karnataka State is found to be similar. Cashew processing data is collected from cashew processing cluster of Dakshina Kannada district, whereas Rice mill process data is collected from Gangavathi rice mill cluster of Koppal district.

### 3.4.2 Sampling in the Study

In the present study, it is intended to understand CP scenario in different sectors of agro based MSME clusters and identify the means for its implementation. As industrial environment for every unit in the respective cluster remains same, it is expected that they perform uniformly in terms of CP practices. However, this is not true due to various reasons.
Hence, defining every aspect to be included in the CP definition of the respective sector becomes essential. To achieve this task, one of the better approaches is to carry out a field survey of the focussed industry cluster, collect all the relevant primary data so as to clearly define the pathways to reap benefits of CP strategy.

However, collection of data for the research is to be efficient to obtain reliable results. The data collected has to be representative of the given population. It is a critical task for the
researcher to select the good sample size. Many approaches and formulae present the basis for sample size selection. According to Roscoe (1975) the ‘rule of thumb’ for determining sample size suggests sample size larger than 30 and less than 500 are appropriate for most research. It is also suggested that when samples are broken into sub samples, then a minimum sample size of 30 is required. Another criterion for sample size determination is whether the research tries to generalise the observation or it is of exploratory nature.

The sample size selection in this research study is largely based on the criterion to meet the factor analysis and multiple regression requirements. Factor analysis is used to extract the latent content in the perceptions about barriers to CP. Measure of Sample Adequacy (MSA) is an important issue in factor analysis. There are several guiding rules of thumb cited by Tabachnick et al. (2007) regarding sample adequacy. As cited by Henson et al. (2006) such rules of thumb may be misleading and often do not take in to account many of the complex dynamics of factor analysis. They have illustrated that when communalities are high (greater than 0.60) and each factor is defined by several items, samples can actually be relatively small. As stated by Guadagnoli et al. (1998), there are a number of studies which have used sample sizes smaller than 50. Jason and Anna (2005) have considered 1700 studies from the PsychINFO (PsycINFO is an abstracting and indexing database with more than 3 million records devoted to peer-reviewed literature in the behavioural sciences, under the American Psychological Association) and have summarized that nearly 15% of the researchers have taken the subject to item ratio 2:1 or less. Multiple regression analysis is the other statistical tool used in this research to examine the influence of various factors on the prevailing CP level. The minimum ratio of number samples to independent variable is 5 to 1.

Keeping the above literatures in mind and also duly recognizing the limitations dictated by time and difficulty of getting the data from the industrial units, the sample size is kept at 40 for each cluster in this research study. Random sampling approach is adopted in collecting the data.

3.4.3 Data Collection

The data for the study from the three selected clusters are collected through a structured researcher administered questionnaire. Separate questionnaire are prepared for the three
industries in the study because of the nature and variability of the processes. However, the questionnaires had the common sections covering the following aspects:

- a. Unit Profile
- b. Material Input
- c. Process Details
- d. Resource Consumption
- e. Product Output
- f. By product Generated and Utilization
- g. Waste Generated and Disposal
- h. Technology Details
- i. Human Resource
- j. Perceived Barriers and Drivers to Cleaner Production

The primary data collected from the three industrial clusters enabled the gathering of information about the unit and processes. The unit profile and process details provide the information about the size and establishment year of the unit, human resource details like age, educational qualification of the owner and number of workers employed, technical details of the process, resource consumption, type of energy required, quantity of different forms of energy, processing capacity and actual processing carried out, waste water and solid waste generated, waste disposal, by-products use, organisational structure, infrastructure details etc. Other details collected are about the state of policy and regulations, awareness and attitude of the entrepreneurs, financial limitations, motivational factors regarding the environmental, and energy efficient technologies.

Apart from the primary data, the study findings also depend on the secondary data collected through published works in journals, conferences, reports of acclaimed organisations like United Nations Industrial Development Organisation (UNIDO), United Nations Environmental Programme (UNEP), Intergovernmental Panel on Climate Change (IPCC), internet, research reports, books and magazines pertaining to selected MSME product clusters.

3.5 METHODOLOGY FOLLOWED

The following paragraphs provide an overview of the approach adopted for ascertaining the opportunities and benefits of CP in MSMEs in the agro-based industrial sector.
3.5.1 Energy Consumption Pattern and Environmental Impact

The first objective is to study the process in bakery, cashew processing and rice mill sector. This was achieved by visiting and studying the industries of respective clusters and observation of the process followed. Literature review also provided various processes adopted throughout the world. Studying the process practiced in the respective cluster and elsewhere will help in deriving the best practice to achieve the objective of CP. Agro-based industries are generally energy intensive that consumes electrical, thermal and labour energy in the process. Hence, it is considered very important to know the energy consumption pattern that enables one to have control over energy consumption. Thus, the second objective was realized through the understanding of energy consumption patterns in the selected industries. A structured researcher administered questionnaire is designed to extract the energy usage of the processing units regarding the type of energy carrier, form of energy, and quantity of energy consumed to process a unit of raw material. Also the environmental impact due to the production process is estimated in terms of greenhouse gases (GHGs) emitted. This was largely based on the calculations in line with IPCC guidelines.

3.5.2 CP Level and Factors Influencing CP

CP is actually the result of amalgamation of many aspects like lesser resource consumption, higher process output, less pollution generation, incorporation of reuse and recycle of by-products and wastes. To improve the CP status, assessing the current level is highly essential. Thus, establishment of the present CP level (CPL) is another crucial objective of the study. As industrial processes are unique in each of the selected cluster, a general method is difficult to evolve. Thus this task of establishment of CP is challenging as no standard approach is available. In fact it is a situation of measuring (quantifying) an almost immeasurable entity. Keeping this in mind, a simple yet widely applicable to a variety of processes is evolved using fuzzy logic approach. In other words this research attempts to assess the CP using a novel approach adopting fuzzy logic. In fuzzy logic, it is convenient to deduce precise values from imprecise data. In this study, imprecision exists in providing the different weightages to various factors affecting CP. In fuzzy logic a mechanism can be devised through which different membership associations can be defined so that the model can mimic the human expertise in calculating the CPL. After the establishment of CPL in the studied units, the next objective considered was to assess the
various factors influencing it. Even though all the units in the respective clusters adopted the same process technology, there was variance in the level of CP. This can be attributed to the factors other than the production technology. Therefore, some of the factors other than technology were identified which are likely to influence the CP. The factors that are considered for this purpose were age of the plant & machinery, location of the plant, processing capacity of the plant, dependence on machinery, extent of plant utilization, education qualification of the owner, attitude and awareness towards environmental strategies and general housekeeping practices. The factors considered above may not be directly associated with the processes. The influence of these factors on the existing CP level is investigated by carrying out multiple regression analyses.

3.5.3 CP Implementation Potential

Even though the estimation of CP level of MSME units in the studied clusters gave an idea about how the units are performing on the basis of the designed measurement scale, it did not convey the information about the potential for improving their performance. Hence, it became imperative to benchmark the CP performance amongst the units in a cluster so that improvement potential could be found and facilitate improving CP further. For this purpose, Data Envelopment Analysis (DEA) approach was adopted using Max DEA Basic version 6 software to know how much of inputs can be decreased or outputs can be increased to make the inefficient units to perform on par with their efficient counter parts.

3.5.4 Barriers and Drivers to CP

After establishing the level of CP and estimating the potential of CP in the studied MSME clusters, the obstacles and catalysts for its implementation is to be understood. In this background, the barriers and drivers for CP based perception of the stakeholders was analysed. With the help of published literature, various dimensions of barriers to the implementation of CP strategy were identified. Important barriers identified were: lack of awareness about the CP strategy; attitude towards its implementation; availability of finance; policy and regulatory issues; and technological barriers. The intensity of each dimension of various barriers was measured using a Likert scale in which the perceptions were obtained on a five point ratings. Subsequently, Factor Analysis (FA) was carried out to bring out the underlying structure of the variables that lead to the identification of strong barriers groups. Also identification and prioritization of drivers for the CP
implementation was carried out by recognizing various drivers and subsequent prioritization using Analytic Hierarchy Process (AHP). Five drivers were identified for this purpose. They were ‘financial benefit’, ‘improved compliance with regulations’, ‘improved quality and productivity’, ‘minimized environmental degradation’, and ‘improved social image’.

All these methodological aspects briefed above are discussed in detail in the respective chapters of this thesis.