CHAPTER 1
INTRODUCTION

1.1 PREAMBLE

Every activity human beings are engaged in pollutes in one way or the other. The civilization has reached a stage where one cannot clean something without dirtying the other. Not even a single industrial activity is an exception to this. The only alternative that is left now is polluting less. One pressing issue that haunts the manufacturing industry in this era is sustainable production. Present industrial systems are not sustainable in the long term because of their demand upon the world’s natural resources. The stability of economic systems of a nation depends on the manufacturing growth and slowing down its rate is infeasible. No country will accept externally imposed limits to their economic development. Sustainable production is the key to this problem which is defined as “the use of goods and services that respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardize the needs of future generations.”

To have sustainable production, Cleaner Production (CP) is one strategy that minimizes the use of resources by adopting efficient practices and generates less waste, and explores ways to recycle the by-products. CP has proven in practice to be a very valuable concept for abating industrial wastes and emissions. It is wise to eliminate or reduce waste and emissions at their source rather than to recover and recycled wasted materials or to eliminate the harmful effects of already generated waste streams. The End-of-Pipe (EOP) technologies will help reduce the harmful effects of industrialization, but CP philosophy tackles pollution and waste problems to reduce the dependence on this solution. The development of CP technologies requires a greater understanding of the environmental linkages to manufacturing processes, products and services, as well as a culture that encompasses waste minimization. CP promotes the use of sustainable business practices and will improve environmental, social and economic performance of the business and will assist in Triple Bottom Line (TBL) reporting.

Smaller industries are very important manufacturing segment in the developing countries and they play a crucial role in economic development and employment growth. To remain competitive, the units need to adopt newer and innovative approaches to upgrade their
technological capabilities. Large industries can deal with environmental and energy saving aspects more professionally, but Micro, Small and Medium Enterprises (MSMEs) are jeopardized with lack of information and expertise, management's resistance to cultural changes and focus on short term profits. Hence, CP in MSMEs is altogether to be viewed from different perspective. CP is far more beneficial to MSMEs than for large industries through economic benefits apart from environmental benefits. Such benefits can be achieved through wise usage of raw materials, energy, and water thus reducing the generation of wastes and emissions at the source itself. CP can be implemented from a simple housekeeping and conscious efforts in reducing the inputs and wastes generated, to the advanced approaches like product modifications, input substitution, technology modification, etc. One important segment of MSMEs is agro-based industry sector, which is typically rural oriented and depends on the agricultural output. These industries are resource starving, consuming huge amount of energy and water. They produce wastes and by-products. They generally adopt traditional processing techniques, owned and managed by entrepreneurs who are not professionally trained but acquired skill and experience only through the heritage.

The present research work is connected with issues pertaining to opportunities and benefits of CP in agro-based MSMEs. This research focuses on aspects that can be adopted without much intervention and investment. Based on the well accepted premises that there is always an opportunity available to improve from the current performance level, it is strongly felt that there are significant opportunities for CP in the MSMEs, especially when they are in clusters. The current research work intends to address them in the context of three agro-based MSME clusters in the state of Karnataka, India.

1.2 ENVIRONMENTAL MANAGEMENT IN INDUSTRIES
In the recent past, around the globe more importance is attributed to reduce environmental impacts from industry. There are many concepts being used and called by various names. All of them have a proactive approach to prevent environmental problems instead of fixing it after it is been created. Burton (1996) has presented these concepts as shown in the figure 1.1 below. Concepts as they go to higher level demands more time and work; covers more scope and better results. Higher level concepts include the concepts below and add additional elements of scope and complexity. In fact the top of the staircase is
sustainable development, is, like quality, a goal which is always elusive and for which we should never stop striving.

Figure 1.1: Staircase of Environmental Concepts (Source: Burton, 1996)

Three types of concepts are seen on the staircase, namely operational concepts, firm wide concepts and macro-scale concepts. Environmental Management Systems (EMS) is not on the staircase. EMS is simply a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency. An EMS can address only one step on the staircase or the whole staircase, depending on the choices made by the organisation.

Operational concepts addresses the specific functions related to the operations. The concepts under this category are Waste Minimization (WM), Recycling, Pollution Control, and Waste Disposal. WM is the reduction, to the extent feasible of hazardous waste that is
generated or subsequently treated or disposed. Recycling is a step on the staircase below waste minimization. The waste creation is more or less inevitable, so they need to be recycled as much as possible. Pollution control systems to reduce waste volume or toxicity are a necessity to manage wastes that cannot be prevented or exchanged. Pollution control requires high capital and operating costs hence this option should be considered only after all the higher level concepts have been thoroughly investigated. The bottom of the staircase of industrial environmental management is waste disposal. While depending on this option should be avoided or else managed responsibly.

The firm wide concepts of environmental management systems address all aspects of the industries operation, from use of natural resources to suppliers to production to product use to product disposal. It comprises two concepts Pollution Prevention (P2) and Cleaner Production (CP). P2 is the use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes at the source. It includes practices that reduce the use of hazardous materials, energy, water, or other resources and practices that protect natural resources through conservation or more efficiently use. (P2) is very similar to CP but is more focused on the manufacturing process. Product design is mentioned, but the priority is on using less toxic chemicals and reducing the generation of waste at the source. So P2 is a little less broad than CP and thus is a step lower on the staircase. CP is a broad concept that addresses all aspects of inputs, production and outputs. It is a firm-wide concept rather than an operational concept because it explicitly includes attitudes and management philosophy as well as business practices. CP is what a good EMS is supposed to implement, and includes the other practices described below. It is broader in scope than pollution prevention in that it explicitly includes product design and use, which is not commonly associated with the pollution prevention concept.

The macro-scale concepts of Sustainable Development (SD) and Industrial Ecology (IE) extend far beyond the firm and include relationships between companies, social institutions, public and the environment in all its facets. IE is the means by which humanity can deliberately and rationally approach and maintain a desirable carrying capacity, given continued economic, cultural and technological evolution. The concept requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a system view in which one seeks to optimize the total materials cycle from virgin material, to finished material, to product, to waste product, and
to ultimate disposal. Factors to be optimized include resources, energy and capital. SD is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It includes practices that enhance community welfare and protect natural resources such as forests, which in the long run lead to a better business environment. The great challenge is to achieve zero discharge of production wastes.

The EMS is the structure within which the other firm-wide and operational concepts on the staircase can be implemented. Of course, this requires a management commitment to implement the other concepts in an organized fashion. An EMS can be limited to only one aspect of a firm’s operations, such as pollution control systems, or it can be very comprehensive, even including external strategies to get involved in industrial ecology. An ISO 14001 synonymous with EMS is a structured system designed to help organizations manage their environmental impacts and improve environmental performance caused by their products, services and activities. International Standards Organization (ISO) promotes the development and implementation of voluntary international standards, both for particular products and for environmental management issues. ISO 14000 refers to a series of voluntary standards in the environmental field under development by ISO. Included in the ISO 14000 series are the ISO 14001 EMS Standard and other standards in fields such as environmental auditing, environmental performance evaluation, environmental labeling, and life-cycle assessment.

1.3 CLEANER PRODUCTION

1.3.1 Development of the Concept

Over the years, industrialized nations have progressively taken different approaches to dealing with environmental degradation and pollution problems, by ignoring the problem; diluting or dispersing the pollution so that its effects are less harmful or apparent; controlling pollution using ‘end-of-pipe’ (EOP) treatment; preventing pollution and waste at the source through a ‘cleaner production’ (CP) approach. The gradual progression from ‘ignore’ through to ‘prevent’ has culminated in the realization that it is possible to achieve economic savings for industry as well as an improved environment for society. This, essentially, is the goal of CP.
The pathway of CP strategy development dates back to Stockholm declaration which emphasised the pollution abatement at the end of a conference on the Human Environment held in Stockholm in 1972. Major industrialized countries were reported in the 1970s to be spending billions of dollars in treating emissions and effluents to satisfy certain requirements before being released to the environment. The situation was becoming progressively more serious as new legislation on the use of chemicals was promulgated in the mid 1970s. The cost of monitoring compliance to the new requirements was mounting as more personnel, both in industry and in government, became involved in monitoring polluting releases.

One estimate is that over US$ 300 billion was spent worldwide each year on environmental projects, most of which was spent on purchasing and maintaining treatment technologies. With the promotion of the ‘polluter pays principle’ by the Organisation of Economic Co-operation and Development (OECD) in 1975, it became the ‘consumer pays for it’ regime. During the latter half of the 1970s the concept of low and non-waste technologies emerged, now shifting the emphasis to pollution prevention rather than pollution treatment. The 1989 decision made by governing council of United Nations Environmental Programme (UNEP) was perhaps in response to this shift of emphasis. A small core group constituted by UNEP thought at first that no justifiable distinction can be made between clean and dirty technology. There is no absolutely clean technology; one technology can only be shown to be cleaner than another. This means that there will always be room for improvement to develop still cleaner and cleaner technologies as time goes on. The ultimate ideal goal is a technology that produces no pollution at all, as if the production process is going on inside a bubble into which raw materials are introduced and out of which come only products. The understanding of the phenomenon has to extend across the whole life cycle of products (cradle to grave analysis). It has to investigate product design, production process, product use and management practices (Ted Munn, 2001).

CP is not a new concept, it is a logical extension of one’s desire to conserve materials and reduce waste. It is not just an environmental initiative, is a ‘win–win’ strategy that protects the environment, the consumer and the worker while improving industrial efficiency, profitability and competitiveness. CP requires changing attitudes, responsible environmental management and evaluating technology options. It does not deny growth; it
merely insists that growth be ecologically sustainable. It should not be considered only as environmental strategy, because it also relates to economic considerations. In this context, waste is considered as a 'product' with negative economic value. Each action to reduce consumption of raw materials and energy, and prevent or reduce generation of waste, can increase productivity and bring financial benefits to enterprise.

Cleaner Production (CP) was finally defined by UNEP as:

"It is the continuous application of an integrated preventive environmental strategy to processes and products to reduce risks to humans and the environment”.

- For production processes: CP includes conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity and toxicity of all emissions and wastes before they leave a process.

- For products: CP strategy focuses on reducing impacts along the entire life cycle of the product, from raw material extraction to the ultimate disposal of the product.

- For services: CP incorporates environmental concerns in design and delivery.

1.3.2 Cleaner Production (CP) and Sustainable Development (SD)

Responsibility of the industry towards environment is indistinguishable from the responsibility of industry towards itself and towards its own shareholders. Thus, environmental responsibility is, and will be, a key driver of SD and international trade. In the past, companies have often introduced processes without considering their environmental impact. They have argued that a tradeoff is required between economic growth and the environment, and that some level of pollution must be accepted if reasonable rates of economic growth are to be achieved. This argument is no longer valid, and the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in June 1992, established new goals for the world community that advocated environmentally sustainable development (ESD).

CP can contribute to SD, as endorsed by Agenda 21. It can reduce or eliminate the need to trade off environmental protection against economic growth, occupational safety against productivity, and consumer safety against competition in international markets. Setting goals across a range of sustainability issues leads to ‘win–win’ situations that benefit
everyone. CP is not a new concept, it is a logical extension of our desire to conserve materials and reduce waste. CP can be especially beneficial to developing countries and those undergoing economic transition. It provides industries in these countries with an opportunity to 'leapfrog' those more established industries elsewhere that are saddled with costly pollution control. It is about integrating - rather than trading off or balancing - the three goals of: Economic development, Environmental protection and restoration, Social Equity and well being.

It is often claimed that CP techniques do not yet exist or that, if they do, they are already patented and can be obtained only through expensive licenses. Both statements are true, and this belief wrongly associates CP with 'Clean Technology'. CP depends partly on new or alternative technologies but it can also be achieved through improved management techniques, different work practices, and many other soft approaches. CP is as much about attitudes, approaches, management and information. About these aspects widely and readily available methodologies exist for application. While it is true that CP technologies do not yet exist for all industrial processes and products, Baas et al. (1992) cited that 70% of all current wastes and emissions from industrial processes can be prevented at source by the use of technically sound and economically profitable procedures. If SD is to be achieved, production processes, products and services have to be reoriented towards new patterns in order to alleviate environmental stress and bring better industrial productivity.

Any environmental management concepts become adorable based on number of environmental issues it addresses. When compared among key environmental concepts, CP encompasses as represented in figure 1.2, several environmental categories ranging from single-media to multi-media. It is more of preventive approach motivated by self responsibility rather than reactive and regulatory driven. It focuses on product life cycle than only on waste streams. CP represents the most frequently used preventive approaches. The older preventive approaches are waste minimization, pollution prevention and toxics use reduction, and each of these tends to focus on one key environmental impact, hazardous waste, toxic substances or pollution respectively. The newer preventive approaches explicitly target reduction of environmental impacts along the product's life cycle, by focusing on product design (design for environment) or on value adding activities (eco-efficiency). The World Business Council for Sustainable Development (WBCSD) developed the word 'Eco-Efficiency' (EE) and identified seven components of
it; reduce material intensity of goods and services; reduce energy intensity of goods and services; reduce toxic dispersion; enhance material recyclability; maximize sustainable use of renewable resources; extend product durability; increase the service intensity of goods and services.

Figure 1.2: Cleaner Production and Other Preventive Environmental Management Systems (Source: Berkel, 2006)

CP overlaps more with EE which caused cost effective goods and services while reducing ecological impact and resource intensity. Implementation of these seven EE components will most often call for five generic prevention practices under the CP umbrella. Implementation of any of these five generic prevention practices will achieve at least one, if not several, of the seven EE components. EE and CP are truly complementary concepts, with EE focusing on the strategic side of business and CP on the operational side of business (Berkel, 2006).

1.3.3 Options of CP
There are several approaches to achieve CP as depicted in figure 1.3, and briefly discussed below:
**Housekeeping** - Improvements to work practices and proper maintenance can produce significant benefits. These options are typically of low cost.

**Process optimization** - Resource consumption can be reduced by optimizing existing processes. These options are typically of low to medium cost.

**Raw material substitution** - Environmental problems can be avoided by replacing hazardous materials with more environmentally benign materials. These options may require changes to process equipment.

**New technology** - Adopting new technologies can reduce resource consumption and minimize waste generation through improved operating efficiencies. These options are often highly capital intensive, but payback periods can be quite short.

**New product design** - Changing product design can result in benefits throughout the life cycle of the product, including reduced use of hazardous substances, reduced waste disposal, reduced energy consumption and more efficient production processes. New product design is a long-term strategy and may require new production equipment and marketing efforts, but paybacks can ultimately be very rewarding.

**Equipment Modification** - Modifying the existing equipment to reduce wastes or improve productivity would help. This attempt requires thorough understanding of the process and may involve small investment.
Efficient Onsite Recycling – Those industries which use the waste generated in the process for some purpose should ensure that it is a valuable input and find its efficient use.

Production of useful by-products – Examining the options to generate some by-products reduces the waste generation.

1.3.4 Benefits of CP

Investing in CP, to prevent pollution and reduce resource consumption is more cost effective than continuing to rely on increasingly expensive EOP solutions. When CP and pollution control options are carefully evaluated and compared, the CP options are often more cost effective overall. The initial investment for CP options and for installing pollution control technologies may be similar, but the ongoing costs of pollution control will generally be greater than that for CP. Furthermore, the CP option will generate savings through reduced costs for raw materials, energy, waste treatment and regulatory compliance. The environmental benefits of CP can be translated into market opportunities for ‘greener’ products. Companies that factor environmental considerations into the design stage of a product will be well placed to benefit from the marketing advantages of any future eco-labeling schemes. CP will assist towards the sustainable management of business. It will also assist to meet the requirements of both the Resource Management Act and local government legal requirements. Some reasons to invest in CP include:

- Improvements in product and processes;
- Savings on raw materials and energy, thus reducing production costs;
- Increased competitiveness through the use of new and improved technologies;
- Reduced concerns over environmental legislation;
- Reduced liability associated with treatment, storage & disposal of wastes;
- Improved health, safety and morale of employees;
- Improved company image;
- Reduced costs in end-of-pipe solutions.

1.3.5 Global Trends in CP

Economic globalization has led to increased industrial and economic competition. Intense pressure is now placed on companies to be adaptable, innovative and agile. Rapid technological advancements and the anticipation of new opportunities and threats have intensified the search for suitable tools to answer these challenges. Consequently, CP has received growing attention in various national and international forums. In developed
countries, global economic forces instigate consumers to demand environmental friendly
goods and the local publics have taken greater interest in local, regional and international
environmental issues. International traders are increasingly demanding improved product
quality while reducing energy, raw materials and water consumption, and minimizing
undesirable emissions. Life-cycle analysis along the entire value chain of a process,
product or service can assist in identifying key areas for interventions to promote eco-
efficiency and responsible environmental management.

In CP adoption, there are differences in various regions of the world that have different
social, economic and political systems. In some part of the world, there are regions where
CP is already adopted in the national policy and regulatory framework while in some other
regions it is still at the infancy. Also there are situations in which CP has successfully
adopted in the absence of supporting structure. This indicates its intervention is still has
got to be imbibed for more understanding into the factors influencing CP adoption in
different regions becomes vital.

Since 1989, the United Nations agencies UNEP and UNIDO, have promoted the concept
of CP and established several National Cleaner Production Centers (NCPCs) in Africa,
Asia, Latin America and former Eastern European countries. To foster commitment to CP,
the UN World Summit 2002 also endorsed the concept of CP in strengthening industrial
competitiveness and reducing negative environmental impacts. The International Cleaner
Production Information Clearinghouse (ICPIC), which is a part of the UNEP-CP
programme, aims to increase World-wide awareness of CP and to help
governments/industry adopt CP as a counter point to the traditional, reactive EOP
pollution control approach.

1.3.6 Status of CP in India
The efforts made in augmenting this strategy in India are significant but not profound. The
UNIDO has been working in India on CP initiatives since the early 1990s promoting
training and consultancy in CP. A mile stone was established when National Cleaner
Production Center (NCPC) started working in 1995 hosted by the National Productivity
Council (NPC). So far NCPC has carried out more than 350 CP and energy efficiency
assessments in key sectors like leather, cement, pulp and paper, dye, textiles and
automobile component industries. It assisted MSMEs in the implementation of viable CP
options which have resulted in significant reduction in pollution load and improving the quality of products. Further, NCPC has established four Regional Cleaner Production Centers (RCPCs) in the states of Karnataka, Gujarat, Punjab, and West Bengal. Alongside RCPCs, local CP centers are coming up in industrial estates in which members of the concerned associations contribute the expenditure while NCPC provides information and technical support.

The combined mission of the State Secretariat for Economic Affairs (SECO) of Switzerland and UNIDO revealed the enormous potential that exists in the MSME sector for CP measures, which culminated in 2002 with the development of the program called "Cleaner Technology Promotion in India (CTPI)." UNIDO is executing the above initiative under the CTPI program with financial support from the Swiss government. The basic objective of the CTPI project is to promote the transfer of cleaner and environmentally sound technologies, not yet commonly used in India, from Switzerland and other OECD (Organization for Economic Cooperation and Development) countries. The project also facilitates the preparation of necessary Clean Development Mechanism (CDM) project documentation, and capacity building of the staff of the Indian enterprises in successful implementation and operation of the projects. Currently, the technologies being targeted under the CTPI project are those for operations in the manufacture of automotive components, for cogeneration, and for the reduction of Persistent Organic Pollutants’ (POPs) emissions.

1.4 CP and MSMEs
1.4.1 Background of MSMEs
In the Indian context Micro, Small and Medium Enterprises (MSMEs) are engaged in manufacturing or production of goods pertaining to several industrial categories. They are defined as follows:

- Micro Enterprises: Those industrial units in which the investment in fixed assets in plant & Machinery does not exceed Rs. 25 Lacs
- Small Enterprises: Those industrial units in which the investment in fixed assets in plant & Machinery is more than Rs. 25 Lacs but does not exceed Rs. 5 Crores.
- Medium Enterprises: Those industrial units in which the investment in fixed assets in plant & Machinery is more than Rs. 5 Crores but does not exceed Rs. 10 Crores.
MSME sector plays a crucial role in India’s industrial scenario which has emerged in the last five decades as a dynamic sector of the Indian economy. They provide large employment opportunities at comparatively lower capital cost and reduce regional imbalances by facilitating equal sharing of national wealth. It has contributed significantly to the socio-economic development of the country. They contribute nearly 8% of the country’s GDP, 45% of the manufacturing output and 40% of the exports (MSME, 2014). They provide the largest share of employment after agriculture. They are the centers of entrepreneurship and are widely dispersed across the country and produce a diverse range of products and services to meet the needs of the local markets, the global market and the national and international value chains. The environmental impacts resulted from their brisk economic activities is remarkable and become increasingly serious, thus sustainability of MSMEs is very important issue nowadays.

Following are the few issues that hinder MSMEs from the planning and implementation of pollution control measures:

- They are generally started without the benefit of long-range project planning and feasibility studies. Entrepreneurs eager to cash in on an attractive business venture normally want to start immediately in the most expeditious manner. In addition, the limited capital cannot sustain prolonged and exhaustive pre-operation project planning and projections.
- They often operate in highly competitive markets and are only marginally profitable. They maximize profit by minimizing their external and other unnecessary expenditures.
- They have limited capital to invest in pollution control activities.
- They are unable to attract people with comparatively high levels of technical know-how in a non-manufacturing process such as pollution control, and they normally require mobile technical assistance for their pollution control.
- Most MSMEs use low level technology and lack space to install pollution control devices.

The CP concept and culture need to be introduced in MSMEs. Many of the CP projects do not need major investments, but what is required is a commitment and training support on how to identify and implement projects.
1.4.2 Barriers to CP in MSMEs

MSMEs have a number of unique characteristics inhibiting the adoption of CP. Even when policy measures are in place their enforcement and monitoring is a real problem on account of the large numbers and diversity of MSMEs. A large number of these firms are not recorded in official surveys. The following barriers to the introduction of CP in MSMEs can be identified:

- Cost of implementing improved operations
- Cost of investigating ways of improving operations.
- Lack of awareness of current regulatory requirements.
- Lack of necessary technological sophistication and economies of scale.
- Greater difficulty in understanding the issues involved in CP.

Even where there is a demonstrated financial return from such investments, MSMEs may lack the resources and expertise to exploit such opportunities. Accordingly, encouraging and facilitating CP amongst such firms presents a significant challenge. CP strategy for MSMEs may initially be more successful if it is tailored to their special characteristics. However, unless firms take on the challenge to acquire a working understanding of the broader principles of CP, continuous improvements and optimal exploitation of opportunities tailored to their unique operations are unlikely.

1.4.3 Motivators to CP in MSMEs

MSMEs produce a major portion of the total industrial waste which pollutes the environment. The use of CP techniques reduces the pollution load from the environment and serves as an effective environmental tool for waste management without sacrificing productivity and profitability. The following motivators are identified to the introduction of CP in MSMEs:

- Reduced expenditure on energy and other resources.
- Reduced expenditure on: packaging, waste treatment/disposal
- Improved compliance with relevant regulations.
- Improved employee morale/enthusiasm.
- Improved employee health and safety.
- Reduced expenditure on materials
- Improved public perception of the business.
1.5 AN OVERVIEW OF AGRO - BASED INDUSTRIES

Agro-based industry is one of the oldest industries on our planet. Being an agrarian economy it was natural that the process of industrialization in India gained momentum and impetus around this sector. Among the total large and medium scale industries in our country, about 45% of them use the agricultural products as their raw materials. The major segments of the agro-based industries comprise:

- Coir Retting Units
- Dairies
- Edible oils & Vanaspati Industries
- Distilleries, Maltries & Breweries
- Rice and Flour Mills
- Food and Fruit Processing Industries
- Jute Industries
- Pulp & Paper Mill
- Starch Industries
- Sugar Mills

Agro-based industries are not free for environmental problems. Based on the available technologies, the wastes from the agro-based industries can be utilized for gainful purpose including use as fuel. Pollution problems in agro-based industry are caused mainly due to the waste water and solid wastes generated during their manufacturing processes. Air pollution problems are caused by such industries during the material handling and combustion processes. Water consumption in agro-based industry generates large volumes of effluents.

The agro-based industry is the second largest generators of pollution due to organic matters in the country, standing next only to the domestic sewage. However, the effluents are bio-degradable because they contain mainly organic pollutants and are devoid of any toxic material, thereby making them amenable to biological treatment. Sizeable quantities of hulls, shells, stalks, steeps etc., are produced during the processing of raw materials and refining the products. Frequently, these materials can be utilized as animal feed or manure or further refined to produce useful and marketable products. Steam and heat are used in large quantities in agro-based industry, and burning fuels results in particulate emissions.
Particulate emissions also occur during handling of raw materials before processing and in the handling and use of wastes after processing. Apart from particulate emissions, odour is one of the major problems in agro-based Industry. In most of the cases, the mal-odorous conditions are due to poor handling and the management of wastes generated.

Apart from the above agro-based industries rely on energy to carry out the desired operations and has to obtain high processing efficiencies in mechanization processes to assure safe storage of agricultural products, and conversion processes that create new forms of food. Electricity and fossil fuel account for a major portion of energy for processing operation, therefore a slight increase in the energy inflow often results in a significant response in production. Hence, there is a particular need for energy management strategy in these industries.

1.6 NEED FOR THE PRESENT RESEARCH STUDY

After understanding EMS approaches, it is clear that these concepts are more of evolving than available in ready to use formats. Companies not attempting to move higher on staircase to attain SD will eventually vanish. One should not forget achieving sustainability is pie in the sky, endorsing continuous improvement. As one goes higher and higher on the staircase to achieve SD, more involvement is required at least until a standardization of the actions are made available. It is also understood that the role of CP compared to other EMS approaches is more promising, as it readily offers an opening for action through its simple approaches. Even the organizations having financial or technical limitations can practice CP since it is a combination of both hard and soft techniques. This does not demand clean technologies or expensive knowhow in every situation. Management’s commitment towards environment, willingness towards sustainable growth is all that is needed initially.

The proposed research work considers examining the opportunities and benefits of CP in agro-based MSMEs. In a developing country like India, this type of study would facilitate the policy makers, industrial entrepreneurs, and other stakeholders to appreciate their role appropriately and contribute effectively. The problem area chosen is considered very relevant and important due to the following:

- MSMEs play a major role in creating employment and economical contribution in developing countries. Individual MSMEs may not be major polluters but they
pollute more per unit of output due to inefficient production, inferior equipment, poor housekeeping and inability to adopt treatment technologies (Frijns and Vliet, 1999). Thus, MSMEs are considered serious polluters due to their pollution intensity.

- MSME sector being diverse and heterogeneous makes the broad-spectrum studies like comparing not just apples and pears, but the whole fruit bowl. Thus Ruth (2004) recommends that future research should consider parts of the sector either as subgroups by size or by industrial sector.

- India being an agrarian country, Indian agro-based sector plays a prominent role. These sectors have to upgrade in all facets of their operation since their contribution in ensuring food security, employment generation, and foreign exchange capability.

- The opportunities, challenges, and benefits of any initiative like CP in MSME clusters are unique and the application of the outcome of the research is relatively easy and rewarding at the cluster level.

It is in this context that the current study is proposed about Opportunities and Benefits of CP in three agro-based Micro, Small and Medium Sized Enterprise clusters.

1.7 CHAPTER SCHEMATA

This thesis is organized in ten chapters. Chapter 2 presents a detailed literature review related to the current study. The published literature on status of CP worldwide, its role in MSMEs in general, and agro-based industries in particular, are presented. The focus is more on the works related to resource consumption and reduction, use of alternate and clean energies, waste reduction, recycle and reuse. The tools and techniques adopted by researchers to evaluate CP performance is presented apart from non-technology aspects like organizational factors, perceived barriers and drivers to understand the phenomenon thoroughly.

Chapter 3 discusses the research framework developed for the present study. It also presents the objectives and scope of research, basis of sampling, and methodology adopted to achieve the stated objectives. Chapter 4 presents the background of the three agro-based
MSME clusters along with their geographical context. Chapter 5 presents the energy consumption pattern and subsequent environmental impact caused by the activities of the considered industries. Environmental impact caused due to energy consumption based on IPCC guidelines and projected environmental impact from the clusters is also provided.

Assessment of CP level in agro-based industries is carried out using fuzzy logic approach in Chapter 6. It also outlines the development of proxy indicators and fuzzy model used for the CP assessment. Identifying factors influencing CP is the core of Chapter 7. It presents the multiple regression models developed for the three clusters. Bringing out the potential for CP practice in the selected industries is another objective of the study as presented in Chapter 8. This is achieved through benchmarking amongst the units within a cluster. Data Envelopment Analysis (DEA) is used for this purpose.

Chapter 9 covers the barriers and drivers for CP initiatives in each MSMEs clusters. Barriers and drivers to CP implementation in the considered agro-based MSME clusters is studied using Factor Analysis and Analytic Hierarchy Process (AHP) methodology respectively. The concluding Chapter 10 presents the summary of various research findings and contributions of the thesis. Policy implications from the findings of the research and the scope for future work in this area are also indicated.