CHAPTER I

INTRODUCTION

Agriculture, for an honourable and high-minded man, is the best of all occupations or arts by which men procure the means of living.

-----Xenophon

Introduction

Majority of Indians live in relatively small localities and are engaged in farming or some activity related to farming. In 2001, seventy two percent of India’s total population was classified as rural, and fifty eight percent of workers were engaged in agriculture. Just 11 percent of Indians lived in large cities of 1 million or more residents (Haub and Sharma, 2006).

Sixty six percent of rural labourers in India are dependent on agricultural activity for their income. Exacerbated by two years of drought in 1965 and 1966, the Indian government turned to high yielding, genetically modified, "miracle-seeds" provided by the World Bank and the United States. These seeds coupled with the Indian government’s assistance and price incentives sparked the Green Revolution in India. Green revolution technologies involving greater use of synthetic agrochemicals such as fertilizers and pesticides with adoption of nutrient-responsive, high-yielding varieties of crops have boosted the production output per hectare in most cases. However this increase in production has slowed down and in some cases there are indications of decline in productivity and production. Moreover the success of industrial agriculture and the green revolution in recent decades has often masked significant externalities affecting natural resources and human health as well as agriculture itself (Subba Rao, 1999). Although these farming methods worked for several years for many farmers they began to show adverse effects in the late 1980s. The overuse of chemical fertilizers caused the soil to become infertile. In order to compete many farmers turned to high cost seeds, fertilizers and pesticides believing
in easier returns. Modified seeds cost nearly twice as much as ordinary ones, necessitating larger loans. Widespread use of agricultural chemicals was harmful to life. All over the world the impact of an industrial approach to boosting crop yields has stripped many small farmers of their self-sufficiency and thrown them into despair and resulted in suicides.

During the ten year period (1997-2006), the average number of farmers’ suicide throughout the country was 15,747 per year during the first half (1997-2001) which rose further in the second half (2002-2006) to an average of 17,513 per year. During the first half of the said decade, the rate of farmers’ suicide was a suicide every 33.3 minutes which worsened during the second half to a suicide every 30 minutes (Jadhav, 2008).

There is need for major review of agricultural policy to meet the changing needs of both producers and consumers. Organic farming will be helpful to solve these problems and make farmers self dependent. Indian agriculture was traditionally organic till middle of the last century. Now it is time to reevaluate our agricultural agenda and combine the old and new agricultural practices together for the development of rural India i.e. Bharat.

**Organic agriculture as a holistic food production management system, which promotes and enhances agro ecosystem health, including biodiversity, biological cycles and soil biological activity.** Organic agriculture is a production system that sustains the health of soil, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved (http://www.ifoam.org). Northbourne (1940), the person credited with first using the term organic farming, advocated a society made up of small, self contained units, a view that has a strong role in modern environmental movements where both people and nature are viewed as being subordinated to the machine or corporate identity. Scofield (1986) described as it does not simply refer to the use of living materials but emphasizes the concept of wholeness. Mannion (1995) refers it as a holistic view of agriculture.

The world’s largest certified organic property (994,000 ha) is located in Australia (FAO, 2002). The total organic area in Asia is now about 8,80,000 hectares corresponding to 0.07 percent of the agricultural area. The number of organic farms is more than 61,000. Interest in organic agriculture continues to grow even though unevenly throughout the
region. There is a wide spectrum of sector development stages from early pioneer status to highly developed markets in Japan (Willer and Yusuffe, 2004).

Organic farming is the use of biomass to increase, improve and maintain the soil fertility that increases the crop production. Biomass is the amount of organic material present in a community or population at given time. Biomass includes every organic matter as agricultural waste i.e. crop residues, farm yard waste, leaf litter, animal manure and weeds.

Although agricultural waste is a general term used to describe waste that is produced on a farm through various farming activities, these activities can include other activities such as seed growing, nursery plots and even woodlands that are used as ancillary to the use of the land for other agricultural purposes. Agricultural waste can be defined as the residues from the growing and first processing of raw agricultural products such as fruits, vegetables, meat, poultry, dairy products and crops. Unwanted plants i.e. naturally growing weeds growing on the farm are also the agricultural waste. Agricultural wastes can be in the form of solid, liquid or slurries depending on the nature of agricultural activities in a farm or agricultural field and can be both natural (organic) and unnatural wastes (Sarmah, 2009).

Weeds are plants growing in human disturbed habitats but do not depend on human intervention for reproduction and survival. These plants may be found growing in agricultural field and gardens (Ngugi et al., 1978, Stephen, 1982). Weeds are considered as competitors to plants and therefore they are generally removed, thrown or burnt. Owing to their longer decomposition time weeds are often destroyed. Weed biomass is an open treasure for crop plants. All weeds are not poisonous but they act as good source of nutrients for crops. They are valued for increasing organic matter, soil fertility, checking soil erosion, including soil formation etc. The best way to control the weed is to make use of it, to promote it to the level of wanted plants. During this period some weeds are more digestible than cultivated forages and have higher crude protein content and are more widely available (Ngugi et al., 1978).

The weeds being rich in protein nitrogen and the C/N ratio is in a very much narrow range as compared to the urban and rural wastes. If this is mixed with biodegradable wastes using well fermented compost as a suitable inoculum which will hasten the process of biodegradation and we can get better quality compost (Biradar, 2002). Use of
Agricultural waste or weeds as a raw material for organic manures is very beneficial for the Indian agriculture.

Organic manures are natural products used by farmers to provide nutrients for the crop plants. There are number of organic manures i.e. green manure, dry manure, farm yard manure, compost, vermicompost, etc. prepared from agricultural or other biological wastes. Organic manures increase organic matter in the soil and in turn releases the plant nutrients in readily available forms for the use of crops. The rate of decomposition of organic manures in soil depends on their C/N ratio, proportions of cellulose, hemicellulose and lignin, climatic conditions and the soil properties. The addition of the organic matter profoundly influences the soil microflora and different groups of microorganisms.

N, P and K are the basic macronutrients for the growth of plants. Nitrogen plays a significant role in photosynthesis, cell division, growth, differentiation, somatic embryogenesis, chlorophyll (Chl) content, rubisco activity, electron transport, photosynthesis, anthocyanin production and is an important component of proteins required for the metabolic processes that take place during plant growth (Chaplin and Westwood, 1980; Novoa and Loomis, 1981; Mordhorst and Lorz, 1993; Guidi, et. al., 1998; Jain, et al., 1999). Phosphorous also plays a role in increasing water use efficiency (WUE), a critical factor for plant productivity in drier climates (Vance, 2001; Wittenmayer and Merbach, 2005), improves leaf expansion, axillary bud growth and shoot canopy, improved photosynthetic surface area and carbohydrate utilization (Ahloowalia, et.al., 2004). Potassium is a nutrient that plays a role in many physiological processes essential for plant growth, absorption of nutrients and its transport including the maintenance for plant water balance and protein synthesis (Fenn, 1940).

Green manuring can be defined as a practice of ploughing or turning into the soil undecomposed plant tissues for the purpose of improving physical structure as well as fertility of the soil. The practice of green manuring is very ancient. The Greeks turned under broad beans 300 years B.C., and the planting of lupins and beans for soil improvement was a common practice in the early years of Roman republic. The Chinese wrote about the fertilizing value of grass and weeds several hundred years before our era (Mogle, 2002).

Weed dry manuring is simple and cheap process of organic manuring. In the process of dry manuring sufficient amount of sunlight is required. Collected weed biomass exposed to sun light for several days with frequent turning to avoid decaying and mixed into the soil
directly as manure. Naturally dried biomass can be used as dry weed manure when weed plants are at 10 to 20 percent flowering stage because at this stage they contain highest amount of nitrogen and other nutrients (Jadhav, 1979)

**Composting** is the biological decomposition of biodegradable solid waste under controlled predominantly aerobic conditions to a state that is sufficiently stable for nuisance free storage, handling and is satisfactorily matured for safe use in agriculture. Composting is not a mysterious or complicated process. Natural recycling (decomposing and recycling of organic matter) occurs on a continuous basis in the natural environment. Organic matter is metabolized by microorganisms and consumed by invertebrates. The resulting nutrients are returned to the soil to support plant growth. Mesophilic and thermophilic bacteria and fungi are the predominant organisms during the initial and the active stages of the compost process. In this process, various microorganisms, including bacteria and fungi, break down organic matter into simpler substances. Although some nitrogen fixing bacteria may be present (de bertoldi, et.al., 1983). Compost is rich in macronutrients and micronutrients. The macronutrients include carbon (C), nitrogen (N), phosphorus (P), calcium (Ca) and potassium (K). However the required amounts of Ca and K are much less than those of C, N, and P. Because they are required only in trace amounts and are frequently referred as the “essential trace elements”. Among the essential trace elements are magnesium (Mg), manganese (Mn), cobalt (Co), iron (Fe), and sulphur (S).

**Vermicomposting** is the process of preparing compost from organic waste with the help of earthworms, the most important of all the large decomposers. The worms consume bacteria, fungi, protozoa, and organic matter. As the worms digest organic material they leave nutrient-rich castings in their path. Unlike other decomposers, they break down material both physically and chemically. Vermicomposts are products of a non thermophilic biodegradation of organic materials through interactions between earthworms and microorganisms (Aira et.al., 2002; Sallaku, et.al., 2009). Some of these earthworms include *Eisenia fetida* (Savigny), *Lumbricus rubellus* (Hoffmeister) and *Eudrilus eugeniae* (Kinberg) (Nagavallemma, et al., 2004). These earthworms improve the soils' physical, chemical and biological conditions for plants growth and nutrient uptake. The accelerated decomposition of plant litter and organic matter by these organisms improve soil fertility by releasing mineral elements in the forms that are available for uptake by plants (Curry, 1987). Vermicompost is characterized by high porosity, aeration, drainage, water holding capacity and microbial activity (Edwards and Burrows, 1988; Edwards, 1998; Atiyeh, et.al., 1999).
Vermicompost is made up primarily of C, H, O and contains nutrients such as NO$_3$, PO$_4$, Ca, K, Mg, S and micronutrients which exhibit similar effects on plant growth and yield as inorganic fertilizers applied to soil (Singh, et.al., 2008). Various forms of organic matter can be used for vermicomposting including animal manure, wastes from manufacturing industries e.g. paper, sugarcane or cotton residues, kitchen and agricultural wastes as well as municipal wastes of organic origin (Alves and Passoni, 1997; Atiyeh, et. al., 1999; Karneam, et.al., 1999; Kiehl, 2001). The nutritional value of the vermicompost is however dependent on its raw material.

Efforts have been made to utilize the agricultural biomass as organic manures for the yield, nutrient content and productivity of the crops.

Rising crude oil prices force us to think about alternative energy sources. Of the different technologies, solar energy is considered the most effective and can even afford the environmental protection of plants.

_The law of conservation of energy tells us_

_we can't get something for nothing,

*_but we refuse to believe it._

Many visionaries think that rather biomass will probably convert the solar energy best and will replace all fossil energy resources in the future. Today, globally most energy is provided by burning oil. Only a very small percentage is generated by nuclear power plants. The contribution of energy from renewable resources is almost negligible but this will change in the future with increasing prices of oil. In the future people may use different technologies depending on their climatic and geographical location.

_Biomass_ is rich in carbon. All plants and animals in the ecological system belong to biomass. Furthermore biowaste from house holds and industry is also biomass. There are several processes to transform biomass into solid, liquid, or gaseous secondary energy carriers: these include combustion, thermo chemical transformation via carbonization, liquification or gasification, physico chemical transformation by compression, extraction, transesterification and biochemical transformation by fermentation with alcohol or aerobic and anaerobic decomposition (Deublein and Steinhauser, 2008).
Due to rising prices for fossil fuels and rising energy demand, bio-energy generation concepts have gained increasing interest in recent years. Scenarios anticipating future developments (Schmid, 2008) show that the usage of biomass for energy purposes will not be sufficient to provide the world’s entire energy demand. Nevertheless it will be of great importance for the next decades until direct conversion systems for energy from sunlight are more advanced. There are two main ways for the recovery of energy from biomass i.e., thermal, chemical or microbial conversion systems. These technologies have been realized in many industrial applications around the world (Insam, et. al., 2010).

Anaerobic digestion is a microbiological process that produces biogas consisting primarily of methane (CH₄) and carbon dioxide (CO₂) in the absence of oxygen. The digestion process occurs in three stages (Mata-Alvarez, 2000; Monnet, 2003). The first stage involves hydrolysis where complex organic compounds are broken into simple soluble sugars, amino acids, fatty acids and peptides by hydrolytic bacteria. The second stage or acidogenesis occurs where these compounds are further broken down into simple molecules by acid-forming bacteria. During this stage, byproducts such as ammonia, carbon dioxide and hydrogen sulfide are produced. The simple molecules from acidogenesis has broken down further producing acids such as acetic acid, butyric acid, propionic acid and ethanol. In the third stage of the anaerobic digestion process, methanogenesis occurs. Here methanogenic bacteria convert the acids into CH₄ gas and CO₂. Methane production can be affected by system pH, temperature and the presence of a number of potentially toxic materials such as salts, heavy metals, ammonia and antibiotics (http://muextension.missouri.edu). The optimal pH range for digestion is between 6.8 to 7.4.

Biogas technology has become interesting as a way to improve the energy release from agricultural residues, save plant nutrients, improve health conditions and quality of life in the villages. The process of biogas generation from crop residues, animal droppings and human wastes has attracted the interest of scientists because of the numerous benefits realized from it. Biogas technology provides a clean and convenient fuel for cooking, lighting, generation of electricity and running of water nitrogen content and more free from pathogens and parasites as compared with the traditionally prepared manures. Besides crop stalks like straw which are otherwise burned as fuel are saved for use as fodder and for the preparation of silage. The digested material obtained after fermentation and releasing the gas is natural organic manure called “Biogas Manure” which contains high concentrations of plant nutrients and organic matter. Biogas slurry manure is richer in essential nutrients, suitable amounts of micronutrients, growth regulators, vitamins and plant hormone. The
manure is free from pathogens, parasites and grass seeds as compared with traditionally prepared from the other organic manures (www.fao.org/ag/againfo/programmes/en/lead)

Rudimentary biogas plants in developing nations such as China and India have biogas as an energy source has significant potential in both urban and rural region using such systems for cooking gas. In rural United States, corporations and farmers are finding value in reusing organic wastes to reduce energy costs and reduce the economic and environmental effects of waste disposal. As the components of biogas continue to be better understood, treatment options and energy use can be optimized to transform farm wastes to environmentally sustainable, valuable economic resources (Bothi, 2007).

In the time of high oil prices and their instability on world market there is a trend of increased research and development in the field of alternative fuels. Biogas technology provide as alternate source of energy in rural India and is held as an appropriate technology that meets the basic need for cooking fuel in rural area using local resources, viz. cattle waste and other organic wastes, energy and manure are derived.

Efforts have been made for utilization of agricultural and domestic wastes for the production of biogas.