CHAPTER 1
INTRODUCTION AND REVIEW OF LITERATURE
"Mother nature has every thing for the needy
and nothing for the greedy"

Mahatma Gandhi

Wastes and weeds are no more wastes but a valuable resource. At present they are available in plenty and current strategy centres around their disposal and eradication only. Economic utilization of those bioresources through direct combustion, biogas production, green manure and compost manure, production, gasification, carbonisation, alcoholic fermentation or oil production can help not only in meeting the challenge of energy crisis but also in keeping environment pollution free (Tyagi, 1989; Goldstein, 1996). The steep increase in the cost of oil and the uncertainty of its availability, realised all over the world have necessitated the need to develop and use the non-conventional sources of energy. Wastes and weeds are available in plenty and in most cases free of cost and in large amounts. Such feed stocks if converted into economical fuels and manures by appropriate technologies can boost rural development and economy, generate employment, minimise pollution and improve living standards of rural mass.

Increasing population, industrialization and urbanization have encroached upon forest land, thereby
creating wood fuel scarcities. The wood available in India is not even sufficient to satisfy the needs of industries like timber, pulp and paper and so on. At such situation, fuel from wastes and weeds for poor and rural people of countries like India appears to be the best alternative.

In India, wastes are available in the form of agricultural residues, agro-industrial wastes, live stock and human wastes, forestry residues, municipal wastes and industrial wastes. These wasted resources if properly utilized can yield solid, liquid and gaseous fuels to meet the entire energy needs of rural people, which comprise 80% population of India.

The burning of cattle dung, wood and vegetable matter in our villages has been a traditional practice. Incomplete combustion of such fuels generate lot of smoke, vitiating the atmosphere and adversely affecting the health of the people. Processing of residues by technologies developed in recent years will not only provide energy and plant nutrients but also gives us clean atmosphere.

The greatest challenge facing mankind in the 21st century is to produce the basic necessities of food, feed, fibre, fuel and raw materials from 0.14 ha or less land per caput. While the use of mineral fertilizer is the quickest
and surest way of boosting crop production, their cost and other constraints frequently deter farmers from using them in recommended quantities and in balance proportions. As a consequence of this and other constraints there seems to be no option but to fully exploit potential alternative source of plant nutrients. Complementary use of available renewable source of plant nutrients (organic/biological) along with mineral fertilizer is of great importance for the maintenance of soil productivity i.e. soil structure, soil bioactivity, soil exchange capacity and water holding capacity.

Weeds are plants which grow in places where they are not wanted. They compete with crop plants for moisture, light, food nutrient and thus reduce the yield of main crops up to 20 to 70% (Vats and Sidhu, 1976; Sharma and Angrias, 1996).

Weeds add to the cost of cultivation, impair the quality as well as reduce the market value of the farm produce, harbour insects, fungal and virus pests that attack crop plants.

Weeds occur in all types of soil and in all seasons alongwith the crops on waste lands and along the road sides. Noxious weeds are major barrier to food production and economic development.
Constant use of synthetic nitrogen fertilizers decrease quality of the feed by increasing total nitrates and nitrites in the fodder which may be toxic to cattle and human being (Bharati Jadhav and Joshi, 1982).

As the constant use of herbicides and weedicides adds to the environmental pollution. If this is allowed for a longer period it will create serious health problem. To stop this growing danger it becomes necessary to find other alternative or look for nutrient source other than chemical fertilizers and other control measures for the noxious weeds for the welfare of the society.

Weeds form a free crop of great potential value, a highly productive crop that requires no tillage, fertilizer, seed collection or cultivation (Tyagi and Tyagi, 1989).

In the beginning there were no weeds. As the plants evolved through ages and covered the earth with a mantle of green, various species hybridized and segregated and by competition and migration sought out their habitats. Gradually there developed on the face of earth a vegetation continuum composed of plant communities (McIntosh, 1958). Those communities related to climate and geography, made up our forests, grasslands, savanas, prairies, chaparral, deserts, tundra, etc. But in this long process of evolution
with its competition and struggle for survival, there was no concept of disharmony of the sort that occurs when man uses plants for his own particular purposes. While plants obviously flourish in an environment of abundance and fail under competition and in situation of limited water and nutrients, we have no evidence that they have feelings and suffer in the ways like animals.

The concept of the weed, then is one that came with man, and one that has long been associated with man's use of plants for food and fiber and for aesthetic and recreational purposes.

As the man moved from the forests and took up agriculture on the stream banks and meadows of primitive world, he started a process that has become a dominant factor in his progress that is he started producing crop plants under conditions of controlled environment.

From the early communities of mixed species, man selected certain plants that produced large seeds or edible fruits or nuts with stored oils or fats. These he slowly domesticated, improved and developed into his agricultural crops. Helback (1959) gives a fascinating description of the early domestication of a number of old world food plants and points out that some were at one time weeds.
Agricultural production consists largely in growing crop plants in pure culture, contrary to nature's ways. In man's efforts to provide favourable environments for growing his specialised crop plants, he first encountered weeds, plants that thwarted these efforts. And in the conduct of these agricultural pursuits from the earliest periods of his existence man has continually contended with certain undesirable species of plants throughout the inhabited world in every country and in every culture.

There are names and descriptive terms for weeds in every known language. It is these plants - "out of place", unwanted, non-useful, often prolific and persistent, competitive, harmful, even poisonous that are known as weeds. That interfere with agricultural operations, increase labour, reduce yields and detract from the comforts of life. As man's life increases in complexity with mechanization, industrialization, and urban living, new and insidious weed situation arise.

To define the concept of weed in early times was not difficult. Farmers in general could name their serious weed pests. But as man's ways of living become more complex, this concept becomes more difficult to describe.
Research on the utilization of weed for more remunerative purposes is in progress in many countries which may induce man to harvest weeds extensively. Thus indirectly controlling them by utilization, and they are proposed for production of paper pulp (Nag, 1973), extraction of leaf protein (Pirie, 1970), green manure (Sanyasi Raju, 1952), composting (Balasubramanian et al., 1972; Gaur et al., 1973) and use of pollutant indicators and abatements (Heggested and Heck, 1971). Certain weedy plants, relatives of crop plants are utilized for transferring their varied pest and stress tolerances to crop plants by breeding.

Many weeds are useful to man for food, clothing, shelter and for drugs to alleviate his illness. Some serve as forage for his cattle, green manure, as hatching and weaving material and many as builders of soil. They soften the contours of the earth with their verdure, and beautify the landscape with their flowers. By scientific methods man has increased the productivity of his crops species and by removing competition and supplying water and nutrients, he has been able to increase yields of several crops until embarrassing surpluses have been accumulated.

By variety of means they commonly multiply and spread rapidly. Because of these characters, weeds add to man's
Uses of weeds:

- Broom
- Fuel
- Condiments
- Fibre
- Green manure
- Biogas
- Soil erosion control
- Flowers
- Compost
- Vegetables
- Yarns
- Medicine
- Leaf protein
labour and resist his efforts at control and eradication.

Weeds vary as plants in general, in size, form, and behaviour. They occur in many families and seldom does one species have all the undesirable characteristics that we attribute to weeds. Some weeds are closely related to valuable crop species and a number of species that are weedy in certain situations may be useful plants in others.

Bunting (1960) points out that during man's development of agriculture weeds of high productivity were actually used as crops. For example oat and rye are more tolerant of extreme northern conditions than barley and wheat. Primitive man probably used many weeds as crops. The last meal found in the stomach of an Iron Age man dug from a Danish bog at Lollund consisted of barley, flax and seeds of Polygonum, convolvulus, P. lapathifolium, Spergula arvensis and Chenopodium album. Other studies indicate that Arrhenatherum tuberosum, Viola arvensis and other common weed plants have served as crops for early man (Godwin, 1960).

No one character is common to all weeds. Varying in their physiology, their morphology, and their general habits of growth, they range all the way from parasites to vigorous independent plants. These undesirable species of plants weeds, profoundly affect human affairs. They concern not
only the large land owner but the small farmer and owner of the city garden plot as well. The orchardists and the vineyardist must guard against invasion of noxious perennial weeds, maintenance engineers of highways, rail roads and irrigation districts have a constant struggle against weed pests. Keepers of parks, golf courses and cemeteries wage continuous warfare against turf weeds and stockmen are increasingly concerned with the invasion of natural range lands and pastures by noxious plants. Implement manufacturers have devised many types of farm machinery to combat weeds, seedsmen and warehouse men must purchase special equipment to remove weed seeds from those of useful species. Federal states and local authorities have drafted laws and regulations to curb the introduction and spread of weeds. Finally, weeds may seriously affect public health. Some species are poisonous to live-stock and humans. Others such as poisoning and poison oak, Parthenium cause severe dermatitis and a great many cause hay fever and other allergic reactions. Burning of weeds, stubble and brush adds pollutants to our air.

We cannot escape the impact of weeds upon our lives, though we may learn to live with them and in spite of them we cannot waver in our warfare against them.
'Prevention is better than cure' is also relevant in weed control. However, in the field of weed control, a farmer necessarily starts with a plant population and in growing crops he attempts to limit the population to a single crop species or a controlled mixture. Thus he is attempting to eliminate indigenous plants in his initial efforts and the introduction of new and different species presents problems only as these new plants are more difficult than the original ones. To hold in check because the plants from older agricultural regions had got more time for selection and adaptation and hence acquired more serious weed habits. Many weed species came from arid, infertile, rugged regions where survival of plants was naturally difficult. When such plants are moved to more favourable environments. They have superior competitive ability. They had to acquire it to survive at home for example *Parthenium*.

In nature many weeds provide pollens as food for beneficial insects and ducts as alternative host to pest predators. There are other wild plants in crop field which repel insect pests and nematodes by their specific secretion. Thus total destruction of weeds will adversely influence the entire agro-ecosystem.
In this laboratory, five luxuriously growing leguminous and non-leguminous weeds viz. Cassia tora L., Achyranthes aspera L., Parthenium hysterophorus L., Euphorbia prunifolia Jacq. and Tephrosia hamiltonii Drumm. were tested for their use in green manuring, compost manuring and for the production of biogas.

GREEN MANURE

Green manuring, as the practice of ploughing or turning in the soil under decomposed green plant material for improving the physical condition of the soil or for adding nitrogen. The practice of green manuring although is in existence in this country from ancient times is confined to certain areas. A number of plants both leguminous and non-leguminous are used in this country for the purpose of green manuring. The choice of a particular green manure crop is made in relation to the soil. The role of green manures in improving soil fertility and supplying a part of the nutrient requirement of crop is well known. Their use in crop production is recorded to have been practised in China as early as 1134 B.C. These are one of the main components of integrated nutrient supply system along with inorganic fertilizers and biofertilizers.
The pH is generally lowered by the use of green manure on soils (Lewis and Hunter, 1940). The ability of strains of garden bean, cowpea and sesbania, Rhizobia was tested qualitatively in the green house, using both negative and positive checks. Garden bean Rhizobia produced good to abundant nodulation on sesban, cowpea, rhizobia produced a few nodules on sesban (Briscoe and Andrews, 1938). The extent to which the abundance of nitrogen will be maintained in the treated manure depends on the nature of green manure. The amount and nature of nitrogen originally present in the green manure and condition under which the material is decomposed.

Legume plants are grown for fixing atmospheric nitrogen through Rhizobium symbiosis and plants after 8 weeks of growth are incorporated in soil to improve its fertility for raising another crop. Sunnhemp, dhaincha, cluster beans, senji, cowpea, moong, urid, fodder legumes etc. are used as green manuring crop. Green manure refers to fresh plant matter which is added to the soil largely for supplying the nutrients contained in its biomass. Such biomass can either be grown in situ and incorporated or grown elsewhere and brought in for incorporation in the field to be manured. Green manure plants may be leguminous or non-leguminous, such
as pigeonpea, green gram, cowpea, soybean, groundnut, perennial woody multipurpose legumes commonly used as source of leaf green manure. The *Spesia* populnea, *Cassia auriculata*, *C. tora*, *Pongamia glabra*, *Melia azadirachta*, *Calotropis gigantea*, *Adhatoda vasica*, *Jatropha gossypifolia*, *J. glandulifera*, *Glicidiccia sepium*, *Ipomoea caruca*, *Leucoena leucocephala*, *Sesbania*, *Cassio-glumera*, *Oesmodium* were collected and used for green manuring in southern parts of India. Weeds e.g. *Croton sparsifolius* and *Locus aspera* also utilized for green manuring.

Leguminous plants are largely used as green manure due to their symbiotic N-fixing capacity. Some non-leguminous plants are also occasionally used for the purpose due to local availability, drought tolerance, quick growth and adaptation to adverse condition. Green manuring is an important practice in several cropping systems though it has received relatively more attention in rice based and sugarcane based system than others. The benefits of green manuring are generally interpreted in terms of their capacity to provide nitrogen or substitute for fertilizer nitrogen. The role of green manures in enhancing the availability of other macro- and micronutrient has not been documented as extensively. It is difficult to compare the relative
efficiency of green manures with chemical fertilizers, even on an equivalent basis. A more rational way is to determine the extent to which green manure could be sensitive for nutrient elements derived from fertilizer to obtain equivalent crop yield (Singh and Sharma, 1983; Sharma and Sharma, 1990). Based on the review of the experiments conducted in different status yardsticks of yield increases in kharif rice due to green mauring @ 6 t/ha are preserved (Leelavathi et al., 1986).

Green manuring has been a popular practice in places where feasible in Godavari delta of Andhra Pradesh and earlier estimate showed that it could provide about 50 kg N/ha in the total N requirement without less in cane yield (Suryanarayana and Seetharamaiah, 1963). Though the climate of tropical South is most suitable for sugarcane growth, 70% sugarcane is grown in sub-tropical north. In South India the response in general is good with sunnhemp (Panse, 1965; Ling Gowda, 1965) and cowpea (Panse et al., 1965). Tephrosia purpurea (Pila) as a green manure on coconut estates in most districts of Ceylon and its control is both expensive and time consuming (Salgado, 1972). Sunnhemp (Crotolaria juncea) and Sesbania sesban could be utilized profitably if a part of protein is extracted from them and the fibre left after
protein extraction is buried into the soil. The yield of wheat per kilogram of N supplied through fibre was greater than the yield obtained when the whole plant was used as green manure (Bharati Jadhav et al., 1979, 1982). Beri and Meelu (1980) found that phosphorus applied to green manure in low phosphorus soils increased the biomass of green manure which when incorporated supplied the absorbed phosphorus to the succeeding rice. Azolla as a green manure, is used in labour intensive farming systems and the potential mechanization of azolla cultivation in rice field (Lumpkin and Plucknett, 1982). Water hyacinth is known as water weed, its uses as a growth regulator, mulch, soil amendment agent, green manure and compost (Ghisad, 1984). Legumes like P. phaseoloides, Mimosa inviso and Calapogonium mucunoides have been recognised as suitable green manure crops for raising in coconut basins (Thomas and Shantaram, 1984). The C/N ratio in improving red loamy soils in a citrus orchard, nutrient uptake and yields of fruit were improved by the green manure treatments (Dai et al., 1985). Four waste land weeds Conyza stricta, Eupatorium odoratum, Tithonia diversifolia and Mikania cordata used as green manure for increase in the paddy fields (Saha, 1986).
Kr-števa Kostava, Mikhailova (1987) used the pea + oats and rye grass species as green manure. Both green manure treatments improved N nutrition and raised P and K contents. The treatment had a greater effect on the K, Ca and Mg content and a correlation was found between leaf potassium and yield. The green manuring increased yield by up to 20%. Floating aquatic weed Azolla coroliniana can provide green manure (Kelvin and Arnazol, 1988). Vigna unguiculata and Sesbania aculeata as green manure intercrops reduce weed growth but rice yield only increased when green manured with cowpea at 12.5 kg/ha (Mathew and Alexander, 1991).

The characteristics of organic matter decomposition in the tropical paddy fields were discussed based on a comparison of the input of organic materials (Rice stabbles, weeds, organic fertilizer), plant debris in soil and total soil organic matter. The amount of organic matter incorporated into the Thai paddy soils in the form of weeds and rice stabbles and amount of coarse plant debris (CPD) were in the same range as those in Japanese paddy soils (Kimura et al., 1990).

A total of 15 annual weed species were assessed for their suitability as green manure plants by determining the nitrogen, phosphorus and potassium contents and DM production.
of potassium grown plants. *Stellanoa mediu* and *Murticaraoa musitina* showed higher P and K than the leguminous weeds. Other species did not meet up to the criteria as potential green manures. *V. grandiflora*, and *Medicago lupulina* showed most potential as green manure plants, by giving high N content and DM production and plant height (Radics et al., 1992).

Weed species *Ipomoea carnea* when used as green manure at pre-transplanting and top dressing with 50 kg N/ha both resulted yields equivalent to those obtained by equal split application of N fertilizer (Kundu et al., 1993). *Sesbania rostrata* is the most popular green manure legume in Tamilnadu, India. *Sesbania rostrata* produces both stem and root nodules in dry season. The entire role of N₂ fixation seemed to be borne by root nodules *Rhizobia* only (Rajavelu et al., 1994). Based on the regression of corn yield with N rates, green manuring with *S. rostrata* and *P. calcaratus* would be equivalent to N application. Both legumes could be used as green manure crops as a resource for poor farmers in developing countries. However in agroenvironments where *S. rostrata* might not fit well, *P. calcaratus* may serve as a better alternative (Munguia et al., 1995).
The aquatic legume *Aeschynomene* show promise as green manures for lowland rice. Most *Aeschynomene* spp. are relatively insensitive to photo period and may be used for green manuring during short day season (de Castro *et al.*, 1995). Utilization of *Crotalaria juncea* as green manure on *Zea mays*, nitrogen content of *Crotalaria juncea* decreased with at all seeding rate, *C. juncea* was incorporated at 30 than at 45 to 60 days after planting. Rapid increase in available soil N was noted within sixth week after incorporation of *C. juncea* at 30, 45, and 60 days after planting respectively. Taller plants with significantly larger ears and more kernel rows per ear obtained the highest grain yields (Marcelino and Fortuno, 1995).

**COMPOST**

Composts are prepared through the action of microorganism on wastes such as leaves, roots and stubbles, crop residues, straw, hedge clipping, weeds, water hyacinth bagasse, sowdust, kitchen wastes, and human habitation wastes. These materials undergo intensive decomposition under medium-high temperatures in heaps, windrows or pits. With adequate moisture in about 2-3 months, an amorphous brown to dark humified material called compost is obtained.
It is more stable in form, valuable source of plant nutrients, helps in maintenance soil organic matter and in improving soil physical condition and biological activity.

Composts are broadly divided into two groups such as rural compost and town or urban compost. Important factors which need to be maintained at optimum level for efficient composting are C:N ratio, C:P ratio, particle size, blending or proportioning of raw materials, moisture aeration, temperature, destruction of pathogens and parasites and use of microbial activators.

C:N ratio of organic material is the most important aspect of composting. The process of conversion of organic material into manure is chiefly microbiological and is, therefore, influenced by the proportions of carbonaceous and nitrogenous, materials that are present in organic wastes to start with microorganism need carbon for growth and nitrogen for protein synthesis. It was found that a C:N ratio of 30 of raw material could be most desirable for efficient composting. The C:N ratio between 26 to 40 as reported by many workers, provide for rapid and efficient composting. Immobilised nitrogen is recycled on the death of some of the organism. Thus the limited nitrogen is recycled by reducing the carbon content of the organic wastes. At low C:N ratio,
ammonia is formed which under favourable condition can be further oxidised to nitrite and nitrate. Other nutrients like phosphorus, potassium, sulphur and micronutrients are also essential for microbial growth. High C:N ratio are generally caused by organic material poor in nitrogen such as cereal residues of wheat, paddy, jowar, bajra, maize sugarcane trash, stalks of cotton, jute and sawdust. Farm and urban wastes have been found to vary widely in C:N ratio ranging between 30 and 80. As the stock of available nitrogen gets exhausted, the activity of nitrogen fixing micro-organisms predominates and thus there is a gain of nitrogen fixed from the atmosphere. With a C:N ratio of raw materials less than 30:1, the proportion of nitrogen is in excess of the requirements of micro-organisms. Although the process of decomposition goes on uninterrupted the unassimilable nitrogen is lost in the form of ammonia gas.

The organic materials most commonly used to improve the soil condition and fertility include farm yard manure, animal wastes, crop, urban organic wastes, green manures, biogas spent slurry, microbial preparation, vermicompost and biodynamic preparation. For all organic matter atmospheric carbon dioxide is the main source of carbon. Methods of compost production used in India are Cimaney and wall method,
NADEP method, Padegaon method, Indore method, Bangalore method. The acceleration of decomposition and the fortification of compost are regulating the C:N ratio.

Cattle and buffalo dung and urine excretion and their characteristics, the results of nutritional trials conducted at National Dairy Research Institute, Karnal. The dung consisted of about 75 to 85 percent moisture, 15 to 25 percent organic matter and 2 to 5 percent mineral matter. The organic matter of dung mainly comprised of 74 to 90 percent of total carbohydrates, 9 to 18 percent of crude protein and 2 to 5 percent ether extract (Neelakantan and Singh, 1975). The faeces of livestock consist chiefly of undigested food which has escaped bacterial and digestive enzyme action. Faeces also contain residue from digestive fluids, waste mineral matter, worn-out cells from the intestinal linings, mucus, bacteria and foreign matter such as dirt consumed along with food undigested protein, excreted in the faeces and the excess nitrogen from the digested protein is excreted in the urine and uric acid or urea.

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. Organic compounds in the manures including fresh crop residues are mineralised in the soil mainly by bacteria, fungi and actinomycetes to carbon dioxide, water and available plant nutrients and intermediate organic metabolites. The addition of organic matter profoundly influences the soil microflora and different groups of microorganisms respond differently. In general, leguminous residues followed by cereal straw supported more bacteria and actinomycetes, Azotobacter population was appreciably increased by the incorporation of cereal straw alone in alluvial soil, Sesbania released the maximum available N, S and P where cereals straw caused immobilization of phosphorus and nitrogen at same intervals.

The principles of production of farmyard manure from cattle shed wastes have been extended for the preparation of 'composts' in which a variety of carbonaceous and nitrogenous waste materials may be utilized. In India, pioneering work in this field was carried out by Howard and Wad (1931) at Indore and followed at Bangalore, who standardized conditions for degradation of leaves, straw and town-refuse utilizing dung and night soil as starters for promoting bacterial activity. Acharya (1939) worked in preparation of manure in pits has been carried out; particularly on the utilization of
town refuse and night soil. This anaerobic decomposition is comparatively slow but markedly less wasteful. During sixth five year plan, Ministry of Agriculture and Irrigation timely launched a programme to set up 35 composting plants in selected cities with a population of 3 lakhs and above.

Besides the above effects, role of compost in the control of plant nematodes and in mitigating the toxic effect of pesticides have been adequately documented (Gaur and Prasad, 1970; Prasad et al., 1972; Gaur et al., 1975). Impact of wheat straw incorporation on yield and protein content of soybean under pot culture condition was reported (Shivashankar et al., 1976). The availability of N from cereal residues can be increased by the addition of N rich organic materials viz. non-edible cakes, fertilizers N (Gaur et al., 1978; Hazra et al., 1974) incorporation. Significant increase in crop yield and N uptake were obtained by using cereal straw and neem cake in the proportion of 3:1 (Gaur and Mathur, 1979). Straw application also increased the productivity of lentil and green gram (Kavimandan, 1980). Enrichment of field soil with 2, 5 and 10 t straw/ha stimulated N-fixing bacteria Azotobacter and anaerobic bacteria (Mukherjee and Gaur, 1980). Rice straw is particularly effective in alkaline soils since its
application decreases soil pH. Stains of microorganisms which can hasten the process of composting of organic residues have been isolated (Misra et al., 1981; Gaur et al., 1982; Bhardwaj and Gaur, 1985; Kapoor et al., 1978). Such microbes are cellulolytic and lignolytic type of microorganism.

Organic or compost manure contain a very large-population of bacteria, actinomycetes and fungi through them not only millions of microorganisms are added but those already present in the soil are stimulated by the fresh supply of humic materials (Balasubramanian et al., 1972; Gaur et al., 1973). The addition of compost improves soil structure, texture and tilth (Biswa et al., 1973; Gaur et al., 1972). Legume residues decompose faster than cereal residue due to their higher N content and narrower C:N ratio (Gaur et al., 1971, 1973). Compost has been found to be very useful in control of soil erosion, several studies on the impact of organic manure on improvement in soil structure were reviewed by Gupta and Nagarajeroa (1982). The quality of urban compost can be improved by blending it with sewage sludge in a ratio 2:1 (Gaur, 1983). Cereal straw caused immobilization of phosphorus and nitrogen at same interval. In general the soils studied there was immobilization of N
during decomposition of cereal straw unless C/N ratio was lowered. However, with compost no such negative effect was observed (Bhardwaj and Gaur, 1985). The amount of animal and human wastes that can be utilized and the amounts of nutrients they can provide for rice production. The combination of organic with inorganic fertilizer is most desirable for manure productive efficiency and N efficiency (Yaun, 1984). Work on the cellulolytic fungi as compost inoculant, *Trichoderma viride* and *Aspergillus* sp. particularly at IARI has been reviewed (Gaur and Mathur, 1990). Enzyme activities in manured soil increased the activity of dehydrogenase but depressed that of nitrogenase (in clay loam and sandy soil). Sandy soil possessed higher dehydrogenase and lower nitrogenase activities than the clay loam soil (El Shinnawi et al., 1988).

The beneficial effect of cellulolytic fungi in composting of dairy farms wastes has been reported (Tiwari et al., 1989a). They also reported the beneficial effect of 10% cattle dung as inoculant and 2% rock phosphate in composting of wool waste containing 66.9% organic carbon and 4.6% N. After 10 weeks compost contained 20.6% organic carbon and 10.0% N with a C:N ratio of 2:1 (Tiwari et al., 1989b). On N basis organic manures were less efficient than fertilizers,
combined use of organic manures and fertilizers was found to be superior than the use of fertilizers alone (Sharma et al., 1991). Because tropical soils are nutrient poor, and because of expensive fertilizer composting and organic waste management in China and India are reviewed (Rao and Wang, 1992).

The highest yield was noted when pelleted seeds were used and both the biogas slurry and coirpith compost were supplied (Jayakumar and Shaji, 1993). Nematodes as indicators of enhanced microbiological activity in a scottish organic farming system. The microbiological activity and nutrient cycling whereas FYM is more likely to bring about long term changes (Griffiths et al., 1994). The decomposed lignin C.N.H. and O concentrations were similar to humic substances in soil. A simulation of microbial production indicated that the microbial biomass was more efficient at mesophilic than at thermophilic temperature (William et al., 1995). Information from fecal caliform research in Canada, Hawaii, and the northeastern U.S. suggest that the fecal caliform level observed in unprocessed yard wastes may represent normal background flora (Meckes et al., 1995). Changes in microbial biomass were monitored by measuring adenosine triphosphate (ATP) level in a bench scale
composting bioreactor. The ATP level were comparable and found to be within a range of 0.1 to 10 μg/g dry wt. compost in bioreactors maintained at 40, 50 and 60°C (David et al., 1996).

Humic acids extracted from composted vegetable residue (green compost) or mixed lignite have been tested for their influence on either soil cracking or microaggregation characteristics. Humic acids from leonardite did not improve soil shrinkage and water stable microaggregates, but rather they determined deterioration of such physical characteristics of the soil tested (Susanna et al., 1996).

**BIOGAS**

Biogas is defined as the combustile gas produced by the anaerobic fermentation of organic residue materials originating from human, animal and vegetable resources. Biogas technology is understood to mean the spectrum of organised knowledge including input, core digester technology and output.

The idea of biogas technology was first conceived for conserving cattle dung was otherwise burnt for domestic fuel. Conservation of organic waste particularly cattle dung was essential to meet the demand of organic fertilizer for
agricultural production. As like cattle dung there are other waste materials like poultry dropping, agricultural residues etc. which can be digested in a gas plant. It is therefore necessary for the experts to work out suitable process through which all the organic waste materials are profitably used for energy production.

In India the biogas programme received attention of the scientists as far back as in 1939. A number of experiments had been undertaken by research institutes and individuals. The pioneering research work done by the Indian Agricultural Research Institute, Delhi, Pune Agricultural College and Dadar Purification Plant in adopting a practical plant for producing combustible gas by using cowdung as the main input. The idea of the present central guide system design plant was evolved in the year 1954 by Shri Jasbhai J. Patel. It was taken over by the Khadi and Village Industries Commission in the year 1962 for field implementation. By continued research work it was possible for the Commission to arrive at the design in use at present and it could successfully implement these designs in the field. There are two main type of plants developed by the commission viz. the vertical and horizontal designs, raising from 2 to 140 cubic meter capacity gas production per day.
Land, marine and agricultural residues were subjected to a bioassay for an ultimate methane yield. At 35°C methane yield were calculated from the percent methane in gases formed and the total volume of gas produced. Methane yield from woody plants were lower in general than from other plant resource group. High methane yield were obtained from several aquatic plants, some crop residues and some root and tuber plant (Aziz Shiralipour et al., 1984). Jerusalem artichoke (*Helianthus tuberoses*) was studied in field experiments in Sweden during 1981 to 1983 in order to investigate the possibility of producing biogas from biomass. An analysis confirmed that economic biogas production from above ground parts of Jerusalem artichoke if possible under certain condition (Gunnarson et al., 1985). Model using soluble carbohydrate content or combined carbohydrate and protein content, are most suitable for predicting the biogas production of a substrate. Analyses of biochemical changes of substrate constituents during digestion also indicate that carbohydrate and protein are the primary components utilized during digestion (Clifford Hbig, 1985).

Market waste consisting rotten vegetables, fruit skins, potatoes, onion etc. was subjected to anaerobic digestion in a 25 liters capacity laboratory scale biogas plant of
floating dome design in the scaled up studies a 200 litres capacity biogas plant produced 30.2 litres kg\(^{-1}\) day\(^{-1}\) at 20 days Hydraulic Retention Time (HRT). The slurry flowing out of the plant could be used as a manure (Ranade et al., 1987). Nallathambi Gunaseelan in Coimbatore (1988) the digestibility of Gliricidia leaves for biogas production was determined in 3 litre batch digesters at room temperature (32±3°C). Determination of the N, P, K content of the digesters influent and effluent slurries indicates that the anaerobically digested slurry of the Gliricidia leaves is better in quality than the fresh Gliricidia leaves as organic manure. The biogas production potential of green laticiferous succulent stems of Euphorbia tirucalli was determined. The slurry consisting of 375 gm fresh cow dung, the proteolytic, cellulolytic and methanogenic organism were higher in E. tirucalli treatment (Rajasekharan et al., 1989).

Filter cake (press mud) from Nellikuppam sugar factory typically contained 71% moisture, 9% ash and 20% volatile solids, with 74-75% organic matter on solids, 20% starter inoculum from a cow dung digester was added and biogas production was monitored for 60 days. The pH was 4.6 initially, 6.8-7.2 (7.1) after digestion. The highest biogas output was 22.81 litres from 8.1 suspension. These also gave
the highest methane contents in biogas (Lakshmanan et al., 1990). The feasibility of using the upflow anaerobic sludge blanket reactors for cassava slop treatment was assessed. The system was two stage. Result indicated that the plant performance was good throughout the experiment and the biogas production was increased. The specific biogas average of methane content was 67% (Dasaratana et al., 1991). Common duckweed (Lemna) on slurry obtained from a KVIC model biogas plant fed on cattle waste was investigated. And recycling of biogas plant effluent through this aquatic plant. The nutrient composition of the plant was the same as plants grown on other media (Balasubramanian and Bai, 1992).

Biogas production from waste material using fixed bed reactors and good performance was observed during the first two weeks. After that gas production decreased gradually since the bed disintegrated and the microorganisms were carried over with the effluent (Supopaong Bhawapathonapum, 1992). Two phase fermentation of untreated whole leaf biomass, involving a solid phase acidogenic system and upflow anaerobic packed bed digester for methanogenesis has been studied. A part of lachate from the acidogenic digester was fed to the methanogenic digester. In the first stage significant levels of gas production occurred from the
decomposing biomass bed indicating a possibility of solid phase fermentation without phase separation if VFA (volatile fatty acid) and pH level are maintained (Chanakya et al., 1993). *Parthenium* is an aggressive invasive weed. Anaerobic fermentation of untreated and NaOH treated *Parthenium* for CH₄ production was investigated in 31 semi-continuous fermenters. The high lignin content of *Parthenium* was one of the factors accounting for the low methane yield. Alkali treatment of *Parthenium* with NaOH significantly enhanced the methane production and cellulose reduction (Nallathambi Gunaseelan, 1994).

The isolation of syntrophobacter wolini a proprionate degrading bacterium in co-culture with a hydrogen utilizing methanogen, methanobacterium faramicicum, from the fermenting slurry of a cattle dung biogas plant in India (Meher and Ranade, 1993).

To enhance the production of biogas from swine wastes, selected cultured bacteria were added to the swine waste slurry before feeding to batch biogas digesters. To obtain homogeneous slurry for uniform gas production, four different microorganisms were tried. *Bacillus mesentricus*, *B. megatherium*, *B. subtilis* and *B. cellulosae methanicus*. The results indicate that blending increased biogas production by
18% and decreased the fermentation from 40 to 25 days. The treatment process increases the biogas yield as well as productivity. The best additives were *B. cellulose methanicus* and *B. metatherium* (Jose and Ming, 1994).

The design, construction and operation of a low-cost small farm-scale digester in Jordan in which cattle wastes were used. The biogas produced contained 65%, CH$_4$ by volume. Production quantities and qualities were measured for a period for more than six months (Aburas et al., 1995).

**DRYING METHODS**

Preservation of surplus vegetables and fruits is the prime necessity of villagers and tribal people because these are not available throughout the year. The traditional method used by them is sun drying which is the cheapest and simplest method for them. Sunlight is available for them free of cost at the day time.

The rainfall in India is seasonal. As a result abundant weeds and vegetables are available in the rainy season and under the favourable conditions during the winter. During the summer months there is an acute shortage of vegetables and the cost will be increased beyond the purchasing limit of the poor citizen. To face this
difficulty an adequate amount of the surplus vegetables are preserved by sun drying.

The green leaves of plants are the original source of most nutrients ultimately consumed by man. The leaves are principal site of photosynthesis then the photosynthates are translocated to the storage organs. Plants produce carotenoids which are the vitamin A precursors. The most common carotenoid and the one possessing the highest vitamin A activity is beta-carotene.

Vitamin A is one of the most important nutrients essential for numerous body processes. Vitamin A deficiency leads to growth retardation, bone malformation, degeneration of reproductive organs, loss of immunity and night blindness. According to estimates, at least 1,00,000 children become blind every year in India due to vitamin A deficiency and other half of these die within weeks (Joshi, 1995). Begum and Pareira (1977) analysed thirty two varieties of edible green leaves easily available in South India for their beta carotene content in different seasons of the year as Amaranthus species, Tribulus terrestris L., Solanum nigrum L., Moringa oleifera L., Sesbania grandiflora Pers., Morind citrifolia L. are an excellent source of beta-carotene.
Drying leads to loss of beta-carotene (Holden et al., 1973; Tekale and Joshi, 1977). Since large amounts of carotenoids are oxidised during storage and drying (Kalyan Joshi, 1981). Drying destroys much of the beta-carotene and damages the protein (Pirie, 1986). Delay between harvesting and processing or consumption is also responsible for the degradation of nutrients in the plant material (Bharati Jadhav, 1979). The drying method plays an important role in the preservation of the nutrient contents of the forage (Kasture and Mungikar, 1982).

After harvest and during drying major changes occur. During oven drying at temperature more than 65°C, protein may be denatured and their properties may change. In the presence of moisture reaction between carbohydrate and protein (Millard reaction) may occur and temperature more than 65°C (Vansoest and Robertson, 1971) which decrease protein degradability changes in other cell wall components may also occur during drying. Therefore, phenolic acids may bind to lignin, hemicellulose and protein.