2. Review of Literature
2. REVIEW OF LITERATURE

2.1. ORGANIC AGRICULTURE – A HISTORICAL PERSPECTIVE

Agriculture in India is not of recent origin, but has a long history dating back to neolithic age of 7500-6500 B.C. It changed the life style of early man from nomadic hunter and gatherer of wild berries and roots to cultivator of the land. The farmers of ancient India were known to have appreciated and adhered to natural laws while developing farming systems and practices. The wisdom gained and practices adopted by these farmers have been passed down through generations and got ingrained in the cultural outlook of the society. The traditional farmers have not only acquired a sound knowledge of agriculture and ecology, but they have also adopted various means of transmitting the information to the posterity. The great epics of ancient India convey the depth of knowledge possessed by the older generation farmers of India.

In a changing world where respect for nature and sustainable use of resources for agriculture and other activities form the accepted pattern of development, a closer look at the traditional agricultural practices is timely and purposeful.

The use of dung as manure appears to have been practiced since the Rig Vedic age (2500-1500 B.C.). The value of green manure like sesamum as manure appears to have been known during the period as far back as 1000 B.C. as reference to the use of stalks and stumps of sesamum as manure appear in Atharvana veda. The practice of the
application of phosphatic manures through bones dates back to about 300 B.C. while the value of animal waste particularly of goats and sheep was recognized in the post Vedic age between 500 B.C. to 500 A.D. (Kautilya’s Arthashastra). Other manures like oil cakes seem to have come to use in the country in relatively recent times i.e., 1000 to 1400 A.D.

The method of preparing dung manure concluded that the loss of nitrogen, which is the chief fertilizing element is minimized when dung heap is left undisturbed; drying dung into balls results in reducing active ammonia, which is injurious to plants; and at the same time placing dung balls in organic matter rich pits increases humus which contributes to the fertility of the soil (Gangopadhyaya, 1932).

Much interest has been shown in the role of organic matter from biological wastes in soil fertility and formation and stabilization of both macro and micro aggregates (Martin, 1942).

L.D. Baver (1951) reported that it is an established fact that a good physiological environment for the plant is one that permits good microbiological activity. The physical condition of the soil is a major factor in root development.

Irfan Habib (1969a) reported that cow dung was used as manure and usefulness of organic materials as fertilizers was certainly known, since fish manure was used in sugarcane cultivation in Gujarat during the 17th century. The peasants were aware of the usefulness of certain crops too in making land suitable for cultivation (Irfan Habib and Raychaudhuri, 1982).

The Harsha Charita of Bana written in seventh century stand as the first clear reference to the actual use of cow dung as field manure. The second source material of
the early 12th century is Vrikshayurveda written by Surapala, who was the physician to king Bhimapala of Bengal and belonged to the early part of the 12th century. This text prescribes specific manures for various crops, trees and plants (Lallanji Gopal, 1980). The third text “Sarangadhara paddhati” written by Sarangadhara, a courtier of King Hammira of Sakambhari (1283-1301 A.D.) prescribes manure both for general and specific use (Peterson, 1888). The use of fish manure in sugar cultivation in Gujarat in 17th century was reported by Irfan Habib (1969b).

According to Lallanji Gopal (1980), the Sanskrit text Krishiparashara, which was probably composed during 1050 A.D. is the only available independent text prepared on agriculture in ancient India. It mentions about systematic and regular use of cow dung as manure (Majumdar and Banerji, 1960 and Lallanji Gopal, 1980).

Venkatateswaralu and Hedge (1992) reported that changes in soil texture, mineral type, indigenous soil salts and the quantity and quality of applied water are factors that may determine the spatial differences in soil physical properties.

2.2. UTILIZATION OF ORGANIC MANURES

Armstrong (1972) reported that undiluted and diluted piggery effluents contained about 28,000 ppm and 10,000 ppm of total solids. Kornegay, et.al., (1976) and Jeffery and Uren, (1979) observed that the Na, K, Ca, Mg and P were increased in soil receiving piggery effluent. Cow manure which usually contains high percentages of organic matter, was found to effectively reduce Pb availability to plants (Zimdahl and Foster, 1976 Scialdone et.al. 1980). Animal manures like chicken manure and pig manure supported better growth than sewage sludges. Application of chicken manure to
agricultural land is a common practice of the local farmers in Hong Kong. However, pig manure produced higher yields of vegetable than chicken manure. This indicated that pig manure also has a high potential as a fertilizer (Cheung and Wong, 1983).

Singh (1984) reported that green manure increased the soil fertility. It is cheaper and a sure source of improving mechanical, physical, chemical and biological properties of soil.

Chakravarty et al. (1985) utilized three organic materials – compost, paddy straw and water hyacinth to study the effect of these manures on alluvial soil. The soil organic carbon increased and the highest effect was observed with compost.

Wong and Lau (1985) utilized various organic manures to ameliorate the soil. The ameliorative roles of refuse compost, poultry manure, Na₄-pyro-phosphate, Na₂-EDTA and CaCO₃ in the reduction of Pb uptake by two crops; Brassica chinensis and Raphanus sativus were investigated. It was discovered that refuse compost and pig manure with their higher organic matter content could reduce Pb uptake in crops by five and seven fold on an average when compared with the control. Na₄-pyro-phosphate and CaCO₃ had similar effects in the reduction of Pb uptake but the effectiveness was lower when compared with two wastes.

According to Ram Singh, et al. (1985), the superiority of FYM and poultry manure is due to the release of aliphatic and aromatic hydroxy acids, humates and lignin. Nimje and Jagdishseth, (1988) observed that FYM acts as nutrient reservoir and upon decomposition produces organic acids, thereby adsorbed ions are released slowly for the entire growth leading to higher yields. Nambiar and Abrol (1989) observed that the declining trend in productivity caused by continuous use of NPK fertilizers could be
curtailed by the use of organic manure. The beneficial effect of organic manures in terms of sustained production could be related to the enhanced biological activities in the rhizosphere, improved soil structure and increased nutrient availability (Nambiar and Ghosh, 1984; Muthuswamy et al. 1990). The application of fertilizer N with green manure or FYM increased the grain yield of crops and sustained soil fertility (Gupta and Gupta, 1997).

Soil degradation or fertility decline has been identified as the most serious problem of existing agricultural systems. There exists in the tropics a wide spread and increasing need for soil conservation and sustainable land use systems (Young, 1989). The usefulness of organic manures in increasing crop yield is well documented by Muthusamy (1990). Manickam (1993) observed that there was a slow but steady decline in crop production with the continuous use of chemical fertilizers alone.

Balasubramanian et al. (2000) concluded that sustained higher crop production can be achieved by the maintenance of soil fertility. It has long been recognized that soil organic matter is the key to soil fertility.

Purkayastha, et al. (2001) studied the ammonia loss from decomposing Sesbania and FYM, measured under controlled conditions by applying the above two to soils left inside sealed conical flasks, establishing air flow and periodically measuring accumulated NH₃ loss using acid traps. The results of the experiments showed the highest loss of NH₃ occurred between 12-15 days of manure application. The quantity of NH₃ lost from green manure was found greater than that from FYM. Kinetics of soil pH and mineralized NH₄⁺-N was well associated with kinetics of NH₃ volatilization loss.
The greater increase of P status in the plot supplied with FYM could be attributed to the addition of P through FYM. The significant increase in available K content has been noted in the plot receiving FYM (Pachauri and Singh, 2001; Singh, et.al., 2001). Singh et.al. (2001) noticed that the application of FYM increased the yield of paddy when compared to the control. The nutrients in the vermicompost were in a more readily available form as observed by Albanell, et.al. (1988). George and Pillage (2000) conducted an experiment with vermicompost on growth, yield and economics of guinea grass grown as an inter crop in coconut. Vermicompost alone and in combination with chemical fertilizers stimulated the crop growth. The use of vermicompost at 5 t/ha. saved the recommended NPK through fertilizer up to 25%. The economic analysis of the data emphasized the need for reducing the reliance on purchased organic manures.

For research planning and better crop production the basic data on physical and chemical properties of soil is essential. These characteristics of an area are very much important to determine the types of crop to be grown. The physical properties of soil have very much to do with its suitability for many uses to which man put it. The rigidity and supporting power, the freedom of drainage, moisture storage capacity, ease of penetration by roots, aeration and retention of plant nutrients are all intimately related with the physical condition of the soil (Muntasir et.al., 2000).

Smith et.al. (2001) concluded that although there is much subjective and expert opinion on current manure practices on farms, there is need for an objective and quantitative study. With novel processes for recycling of wastes and efficient utilization, it is possible to conserve available national resources and to recover useful products (fertilizers, fuel, feed etc.) and in some cases to combat disposable problems and minimal
pollution effects. Preservation of the quality of the environment is vitally linked with the extent to which waste can be recycled and utilized. The major benefits of recycling of organic waste have been described by Vimal and Talashilikar (1983).

Mishra and Tiwari (2001) reported that fertilizer plays tremendous and vital role in increasing the food grain production. Unfortunately our Indian farmers use only NPK fertilizers and that too in imbalance proportion giving major emphasize to N only. Nitrogen, phosphorous, potassium, sulphur and microbial inoculation enhance the magnitude of metabolic process in the plants resulting in higher production of photosynthesis and in turn in the yields. They also improve the quality parameters of grain through better absorption and utilization of minerals.

2.3 COMPOSTING

Nijhawan and Kanwar (1952) observed that earthworm soil contains more organic matter, total nitrogen and total phosphorus compared to parent soil. Gupta and Sakal (1967) reported that earthworm soil contains more available phosphorus and nitrogen. Parle (1963) found that the earthworm casts harbour increased number of microorganisms. Parthasarathi and Ranganathan (1998) recorded similar types of bacteria and fungi in the pressmud and pressmud mixed with sawdust. Watanabe (1975) found that the concentration of exchangeable calcium, sodium, magnesium, potassium and available phosphorus and molybdenum were high in earthworm casts than the surrounding soil.

Arakari et al. (1962) recommended the Padegaon method for composting resistant substrates like sugarcane trash and cotton stubbles. Balasubramanian et al. (1972) and
Gaur et al. (1973) found that organic manures/composts contain a very large population of bacteria, fungi and actinomycetes and also stimulate those already present in the soil. Gaur et al. (1973) also suggested that the organic composts harbor a very large population of bacteria, actinomycetes, fungi and also stimulate the enrichment of soil macronutrients.

Poincelot (1975) reported that the compost, previously amended with rock phosphate, with culture to Azotobacter chroococcum and the phosphate solubilizing strain Aspergillus awamori increased the total nitrogen and humus content appreciably. Waksman and Starkey (1939) brought out the role of individual groups of microorganisms as well as mixed cultures as inoculants on aerobic decomposition compared with pure culture. Gaur et al. (1973) showed an improved manurial value of compost when inoculated with Azotobacter chroococcum and Phosphate solubilisers. Gaur (1980) has investigated the effect of microbial (bacteria and fungi) inoculants on the composting of rice straw and Karanji leaves (Pongamia pinnata).

Krishnappa et al. (1977) reported that biogas slurry is well decomposed and rich in NPK and it also contains trace elements like zinc and iron. It has higher fertilizing effect than decomposed dung since it contains greater amount of water-soluble nitrogen which is easily available to plants. Asija et al. (1984) noted that cowdung and waste fodder enriched with fertilizer viz., urea, super phosphate and rock phosphate were used to improve the quality of soil. Fontenot et al. (1983) analyzed and reported that poultry wastes contain higher concentrations of nitrogen, calcium and phosphorus.

Holter (1979) reported the increase in the level of macro and micro nutrient contents in vermicomposted cattle dung. Similar observation was made in maize and
soyabean plant residues (Mackay and Kadivko, 1985). Lee (1985) Edwards and Bohlen (1996) reported that earthworm casts usually have greater populations of bacteria, fungi, actinomycetes, more enzyme activity, larger concentrations of available nutrients and greater structural stability than the surrounding soil aggregates. Shaw and Pawluk (1986) Lavelle and Martin (1992), Sannigrahi and Chakraborthy (2000) found that earthworm casts are enriched in terms of available nutrients, microbial numbers and biomass, relative to the surrounding soil.

Elliott et al. (1981) suggested that all the organic wastes cannot be applied or ploughed directly as such into the soil because of their variation in decomposition and wide C:N ratio. They are known to immobilize the available mineral nutrients, which would affect the nutrients availability to the crops and also known to produce some phyto-toxic substances during their decomposition (Martin et al. 1978). Gaur et al. (1984) noted that no turnings need be given to the heaps and the material decomposes more quickly than in pits which can be quickly used after three to four months.

Saddler (1986) observed that in an anaerobic environment, the plant litter is mainly decomposed by the activity of the saprophytic fungi through secreting a large amount of eco-enzymes directly into the environment. Zucchini and De Bertoldi (1987) proposed that a compost should be considered hygienic if a 100 g sample contains no salmonellae, no infective parasitic ova and no fecal coliforms more than $5 \times 10^4$ and $5 \times 10^5$ fecal streptococci. Balamurugan et. al. (1999) noted the enhancement of calcium, magnesium, sodium, iron, copper, manganese and sulphur during composting.

Agricultural utilization of residues as organic amendments has been shown to be a sound alternative for both residues recycling and soil fertility improvement. In recent
years however the environmental problems associated with excess nutrients applied with a manure/biosolids have become acute (Logan, 1990).

Several authors studied the role of earthworms in organic matter decomposition, nutrient cycling, soil structure and plant productivity (Lavelle, 1988; Scheu and Wolters, 1991; Zhang and Schrader, 1993; Blair et al. 1994 and Stephens et al. 1995). Tiwari and Mishra (1993) and Daniel and Karmegam (1999) noted that the increase of microorganisms is due to the activity of earthworms and their castings. Manna et al. (1994) observed significant increase in water soluble carbohydrates after decomposition of wheat, chickpea, straw and city garbage treated with earthworms. Tomlin et al. (1995) suggested that the microbial activity is greater in casts than in un-ingested soil which contributes greatly to the increased stability of casts.

Ramesh and Gunathilagaraj (1996) studied the degradation of coir waste and tapioca peel by earthworms with and without feed under laboratory conditions. They concluded that the rate of degradation was maximum in treatments with earthworms that received cow dung as feed. Degradation was marked by the decrease in organic carbon content, the C/N ratio and the subsequent “increase in macro and micro nutrient contents and microbial activity in both coirwaste and tapioca peel”. Edwards and Bohlen (1996) reported that earthworm casts are rich in ammonia and partially digested organic matter and provide a good substrate for the growth of microorganisms. Asha Gupta (1997) pointed out that casts of the worm collected from the experimental pots were found to have enhanced level of pH, high contents of organic matter and nutrients than in the parent soil. Ismail (1995) has said that earthworms promote microbial population by virtue of their own intestinal mechanism or by their casts, serving as best culture media.
Talashilkar et al. (1999) reported that vermicomposting of all the residues resulted in significant reduction of C:N ratio and increase in other parameters like humic acid content, cation exchange capacity and water soluble carbohydrate content of all the residues after 150 days of composting over the residues un-inoculated with earthworms. Ghosh et al. (1999) observed higher level of transformation of phosphorus from organic to inorganic state and thereby into available forms during vermicomposting compared to ordinary composting.

Venkatraja et al. (2001) analysed the physicochemical and microbial properties of vermicomposting, biodung cum vermicomposting and the Chinese method of composting and reported that porosity and water holding capacity of the compost increased significantly while the temperature, electrical conductivity and bulk density values decreased slightly. Further they concluded that based on the physicochemical and microbial features, they adjudged, biodung vermicompost method as the best due to its high nutrient value and its physical structure.

Benito, et.al. (2005) studied the maturity and stability degree of pruning waste. They have collected four compost samples from pruning waste, viz., initial non decomposed material, 2 months old at the end of the bio-oxidative stage, 7 months old during the maturation stage and 12 months old at the end of the maturation phase. They observed that C mineralization and microbial activity of the compost at different stages.
2.4 ORGANIC MANURES ON THE PHYSICAL PROPERTIES OF SOIL

Sharma et al. (1956) observed reduced bulk density at higher altitudes (in hill stations) principally due to higher organic matter content. Continuous application of FYM reducing the bulk density has been observed by Havanagi and Mann, (1970), Anderson and Gantzer, (1989) and Anderson et al. (1990).

Salter and Haworth (1961), Biswas and Ali (1969) and Sundaramurthy, (1973) reported that the soil moisture was increased through the incorporation of organic matter. The application of cattle manure improved the moisture content of the soil and increased the water holding capacity of the soil. Salter and Williams (1963) reported that FYM was effective in increasing water holding capacity of some British sandy soils. Haynes and Naidu (1998) concluded that the soil organic matter increases moisture content and water holding capacity of the soil.

The pH of the soil was slightly affected due to the application of FYM (Bopiah, 1970; Palaniappan, 1975; Chaudhary et al., 1981). Haimi and Huhta, (1987) stated that the decrease in pH is an important factor to be considered influencing retention of nitrogen. Sarkar and Singh (1997) observed that sole application of FYM decreased the soil pH to 6.6 from the initial value of 6.7. Mayalagu and Jawahar (2000) observed that the soil pH decreased due to the application of coir pith to the black clay soil indicating the acidifying effect of organic acid produced upon decomposition. Sarkar et al., (1989) stated that electrical conductivity depends on the concentration of different bases in the soil solution.

Green manuring, apart from increasing soil fertility, improves the soil physical condition (Biswas and Khosla, 1971).
In Nigeria, Wilson et al. (1982) and Hulugalle et al. (1986) observed that certain species of cover crops were able to increase the water holding capacity and infiltration of a severely degraded alfisol through increases in its organic matter content and decreased bulk density. Mac Rae and Mehuys (1985) suggested that available water holding capacity was increased in sandy soils with inherently low available water holding capacity.

Hapez (1974) reported that cattle and horse manures (which contained more fibrous materials) were more effective than poultry manure in decreasing soil bulk densities and increasing their water retention capacities and infiltration rates. He further noted that the magnitude of structural improvement was higher for the sandy clayey soil.

Soil organic matter decreases bulk density by the addition of denser mineral fraction of the soil (Wallingford et al. 1975). Soil organic matter will influence water holding capacity directly by increasing the specific surface area of the soil (Gupta et al., 1977) and indirectly, by increasing aggregation generally so that the total number of pores are increased (Pagliai et al. 1981) and by decreasing bulk density so that pore size distribution is changed (Khaleel et al. 1981). Rao et al. (1978) and Sands et al. (1979) observed that the application of organic matter to soil decreased the bulk density.

Aina and Egolum, (1980) and Mbagwu, (1985) stated that research methods of improving the poor physical condition of soils using organic amendments lags far behind that aimed strictly at fertility improvements. Singh, (1984) stated that the green manure improved the mechanical, physical, chemical and biological properties of the soil. The application of organic manures to the soil plays a vital role in sustaining high yield and improving the physical properties (Verma and Bhagat, 1992).
Metzger and Yaron, (1987) and Ekwue, (1992) found that the addition of organic matter improved the soil surface structure, stability, porosity and water infiltration. A further factor noted by Weil and Kroontje (1979) is earthworm activity. They noted that infiltration rate was increased on plots with more soil organic matter because of greater earthworm activity creating channels to the surface.

Metzger and Yaron, (1987) reported that the rapid saturated hydraulic conductivity is important for transporting water from the soil surface to deeper layers during rainfall or irrigation (thereby decreasing runoff or erosion potential and improving aeration). Most experiments report that increasing soil organic matter increased saturated hydraulic conductivity by decreasing bulk density and increasing total porosity. Unsaturated hydraulic conductivity is also important for water movement to roots as the soil dries. The limited amount of data similarly suggests that this is improved by increasing soil organic matter. (Khaleel et.al. 1981). Soil strength, as indicated by aggregate stability has been subjected to much research. Positive correlation between soil organic matter content and aggregate stability has generally been reported (Chaney and Swift, 1984).

There are numerous reports on improved physical condition of soil following manure application (Verma and Bhagat, 1992; Haynes and Naidu, 1998) or sludges (Khaleel et.al. 1981) or green manure (Rao et.al. 1971; Singh, 1984). These clearly demonstrate the general benefits of increasing soil organic matter levels on soil physical properties.

In a laboratory study, the potential use of the organic wastes, poultry manure, compost, saw dust, brewers' spend grains, rice (Oryza sativa) shavings, gmelina
(Gmelina arborea) and cashew (Anarcadium occidentale) leaves to improve the structure and water retention properties of an ultisol was evaluated. These wastes were applied at the rates of 5% and 10%. Additions of the wastes at both 5% and 10% decreased bulk density but increased total porosity, saturated hydraulic conductivity, water retention at different potentials as well as the organic matter contents of the soils (Mbagwu, 1989).

The studies of Singh et.al. (2000) indicated that application of FYM significantly brought down the bulk density of both surface and subsurface soils in comparison with control. Application of different levels of fertilizer did not affect the bulk density. Neither organic nor inorganic fertilizer could affect the porosity of the surface soil. However, higher porosity of subsurface soil was recorded due to application of FYM and green manure (Sesbania rostrata). Combined application of FYM and recommended level of NPK recorded maximum water retention at both field capacity and wilting point. Root length, bulk density, dry matter added through root was significantly higher in FYM treated plots.

Eghbal, et.al. (2004) observed that the residual effect of manure and compost application significantly increased soil electrical conductivity, pH levels and plant available P and NO₃-N concentration.

2.5 ORGANIC MANURES ON THE CHEMICAL PROPERTIES OF SOIL

The availability of potassium in the soil was derived from the weathering of potassium containing minerals, a process encouraged by acidity and consequently by the presence of decomposing organic matter (Kanwar and Prihar, 1962). There are many workers who observed that the FYM resulted highest availability of potassium when
compared with different types of organic manures (Sahu and Nayak, 1971; Singh et al. 1983; and Kumaresan et al. 1984). The comparative study of FYM and poultry manure was conducted by Sharma et al. (1988). They concluded that there was a gradual build up of organic carbon, N, P and K in soil which was maximum with the use of FYM than green manure.

Singh and Tiwari (1968) reported that available P was relatively higher when FYM was applied than poultry manure and goat manure. The continuous application of organic manure and recycling of crop residues increase the available P content of soil (Havanagi and Mann, 1970; Singh et al. 1983; Yaduvanshi et al. 1985; and Bhat et al. 1991). Singh and Srivastava (1971) and Prasad et al. (1971) observed that available P was significantly increased in soil with poultry manure and FYM application. The application of organic manure increased the available P content of the soil (Mc Intosh and Varney, 1973; Mukherjee et al. 1979).

According to Prasad et al. (1971) the build up of soil organic carbon was due to organic farming through application of FYM. Singh (1978) and Sharma et al. (1988) observed that FYM recorded the highest organic carbon and available phosphorous content in the soil when compared to other types of organic manures. The increased percentage of organic carbon in the soil due to the application of organic manure was observed by Generiri et al. (1991). The addition of biogas slurry to the soil increased the organic carbon content of the soil (Meng Xun et al., 1991; and More, 1994). Singh et al. (1999) reported an organic carbon status with the application of 5 tons of FYM along with fertilizer N.
Hornick and Parr (1987) have reported improvement in N use efficiency following the application of fertilizer N in the presence of organic manures.

Levi-Minzi, et.al. (1990) conducted an experiment to determine the rate and extent of decomposition of three animal wastes (FYM, pig slurry and poultry manure), two urban wastes, sewage sludge and municipal refuse compost and one crop residue (rye straw) in a sandy loam soil.

Sharma and Mittra (1990), stated that the beneficial effect of organic amendments improving physical and chemical properties of the soil are largely attributed to the storage of nutrients in early plant growth stages probably through increased microbial activity and their subsequent release at later stages through mineralization. The addition of organic matter increased the nitrogen content (Olsen, et.al., 1970) and immobilized the available N followed by a steady mineralization (Singh and Srivastava, 1971). The application of FYM increased the available N content (Somani and Saxena, 1975). Singh and Lal (1976) observed that the nature and quantity of applied organic material has great control on the available nitrogen content of soil.

Bose and Mukherjee (1993) noticed that application of organic manures in general, improved the availability of micronutrients like, zinc, iron, manganese and copper. The existence of positive correlation between availability of zinc and organic matter was observed in many experiments conducted by various workers (Kanwar and Randhawa, 1969; Follett and Lindsay, 1971; Balausndaram et.al.1973; and Vittal Gangwar, 1974). Rajagopal et.al. (1974) reported a negative correlation between available copper and organic matter while Saba et.al. (1982) reported a positive relation of copper to organic matter and clay of the soil. Balasubramanian and Ramaswami
(1983) reported that organic matter addition influenced the available copper, but it varied with the type of the soil. Singh et al. (1980) observed the continuous application of FYM in the semi arid region of Haryana resulted in an increase of exchangeable calcium and magnesium. Ponia et al. (1984) concluded that soils enriched with natural or applied organic matter had higher preference for Ca\(^{2+}\) as compared with those low in organic matter. The application of enriched FYM and composted sugarcane trash significantly enhanced the available iron in soil (Deepa Devi, 1992). Saha et al. (1992) reported that the extractable copper contents of the soils showed significant positive correlations with organic carbon and clay of the soil.


Smith et al. (2001) observed that the poultry manures are a valuable source of plant nutrients (estimated current value about £ 50 million per annum) and organic matter, which can provide savings on inorganic fertilizer applications and help to maintain soil fertility. Animal manure slurries contain a great proportion of soluble N.
than FYMs, indicating that slurry N is more readily available for plant uptake than N supplied by FYM (Smith et al. 2002).

2.6 ORGANIC MANURES ON THE BIOLOGICAL PROPERTIES OF SOIL

Several authors have demonstrated that the incorporation of different organic materials to soil contributes to the reduction of nematode populations in plants (Lindford et al. 1938; Patrick et al. 1965). With regard to this latter observation, Hunt et al. (1973), working with sandy soils, studied the effects on nematode plant-parasite populations. These authors indicated that certain species (Helicotylenchus sp) were considerably reduced in number, while others (Criconemoides spp) remained unaffected. In addition, Hunt et al. (1973) observed that aqueous extracts of compost immobilize soil nematodes (Belonolaimus longicaudatus). Furthering these studies, Tarjan (1977) added composts to citrus fruit plantation (orange and lemon trees) parasitized by different nematodes and evaluated the infection-suppressing capacity by measuring crop yields.

Zrazhevskii (1957) observed the increase in the bacterial population from the vermicompost applied plots. Rothwell and Hortenstine (1969) working with sandy soils, found that the fungal population increase progressively with time and amount of dose. At first, the number of bacteria increased considerably, but after the sixth day it began to decrease, presenting final values slightly higher than the control soils. The release of CO₂ increased with compost incorporation. This release was more intense than that observed with cow manure but less than CO₂ released by chicken manure or activated sludge. These authors also observed that compost depressed nitrification when compared to other organic manures. This phenomenon would explain the nitrogen – deficient status
observed in plant by certain investigators who worked with this sort of material. Results from incubation study (Loewen-Rudgers et. al., 1981) indicated that the rate of refuse decomposition was not influenced by the amount of supplemental N or by N carrier, probably because the soil and / or the refuse supplied substantial N. Nitrate levels in most treatments including refuse were similar to or lower than, those in the control (soil alone).

Hunt et.al. (1973) observed that aqueous extracts of compost immobilize soil nematodes (Belonolaimus longicaudatus). Furthering these studies, Tarjan (1977) added composts to citrus fruit plantation (orange and lemon trees) parasitized by different nematodes and evaluated the infection-suppressing capacity by measuring crop yields. Yields were slightly improved although differences were not significant.

Regarding the beneficial role of organic matter in agriculture Cook (1976) indicated that the oxygen – ethylene cycle is enhanced in soil when organic matter or compost is added. Its benefits include protection against soil-borne diseases, the interruption of the reproduction cycle of plant pathogens, and the stimulation of a variety of hormonal responses by the plant when exposed to ethylene gas produced in the soil.

On the other hand, Kropisz and Russel (1978) compared the effects of compost of varying degrees of maturity on the micro flora content of a soil. Both total and fungal microflora decreased as the degree of maturity rose, while the number of actinomycetes increased. The effect of organic matter in increasing the microbial population has been reported by Gaur and Mukherjee (1980). Like wise, Miyashita et.al., (1982) observed increases in the number of actinomycetes when composts were applied to different types of soils, and Hoffman (1983) reported that municipal waste compost slightly increased
the plate counts of bacteria and significantly increased the number of particular genera (e.g. *Azotobacter*).

Kapoor *et al.* (1983) and Mishra *et al.* (1984) reported that the *Aspergillus awamori* fungi transformed the rock phosphate-P from insoluble to soluble form and the solubilized P content was higher in P-enriched compost inoculated with it. Phosphobacteria helps to dissolve the insoluble P to easily available P that in turn enhanced the growth and yield of plants (Raut and Ghonsikar, 1983; Ramamoorthy *et al.* 1997).

Pera *et al.* (1983) investigated the effects of composted organic matter from solid urban waste mixed with urban sewage sludge, on rhizosphere microorganisms of sorghum plants in two different soils. Microbial populations showed variations closely connected either with increasing doses of organic matter in both types of soils or with the characteristics of each soil. Increasing doses of compost positively enhanced the growth of total fungi and actinomycetes and doses of compost also stimulated total aerobic bacteria load, which reached a maximum in both soil types after 45 days.

Rani and Sanoria (2001) conducted field experiment to study the microbial population in soil at different growth stages of soybean crop using two strains of *Bradyrhizobium Japonicum* alone as well as in combination with *Pseudomonas striata*, cattle dung manure, digested sludge and pyrites. The treatments significantly increased the total bacterial population, fungal population and actinomycetes population.
2.7 EFFECT OF ORGANIC MANURES ON CROP PRODUCTION

Rossner and Zebitz (1986) observed that neem leaves and neem seed kernels (1\% v/v) increase the size of plant, number of leaves, weight of shoots, roots and yield of tomato. Karmegam et al. (1997) recorded maximum shoot length, root length, fresh weight and dry weight in vermicompost applied radish (*Raphanus sativus*). Kumar et al., (1997) found that organic amendments and chemicals favored the yield of Tomato. Hossain and Mohanty (1999) observed in the vermicomposted field that an increase in the levels of nitrogen and potassium significantly increased the plant growth, yield and other yield attributing characters in tomato.

FYM application increased the yield of tubers (Ravindran and Bala Nambisan, 1986) and biomass (Islam et al. 1998). Raj Mohan and Sethumadhavan (1980) suggested an application of 10 tons of farm yard manure along with NPK increased the *Coleus parviflorus* yield.

Goswami et al. (1998) observed that the increase in plant growth of cow pea was recorded with Hind-o-meal which is a mixture of oil seeds of *Melia azadirachta* and *Azadiracta indica* NPK and bone meal. Karmegam and Daniel (2000) observed that biodigested slurry gave more yield in crop plants like cowpea at field level by supplying with all essential nutrients which enhanced the activity of microbes in the soil which in turn maintained the soil health.

Bawa (1995) and Srinivasa Reddy and Uma Mahesh (1995) observed a significant increase in dry matter and yield of green gram upon application of vermicompost and FYM.
Joseph et al. (1995) observed that the addition of composted coir pith to soybean increased the number of pods per plant, pod length and pod yield. Soybeans, groundnuts, black gram, moong and lentils were inoculated with *Rhizobium*, *Bacillus polymixa* and *Glomus fasciculatum* in different combinations in a pot experiment. Nodulation, plant growth, P uptake and population of microorganisms in the rhizosphere were found highest in combined inoculation with all three microorganisms (Ghose and Pol, 1998). Sharma and Namdeo (1999) observed that the N,P and K contents of seed, straw, seed soil and protein contents of soybean were greatest with *Rhizobium* along with FYM and phosphorous solubilizing bacteria (*P. striata*, PSB). The N status of post harvest soil remained unchanged and K status tended to decrease with increasing P rate.

Tiwari et al. (1997) observed that biogas slurry and sugar factory press mud along with 50 % recommended NPK were beneficial for higher growth characters, yield, quality and nutrient uptake in sugarcane crop.

The effect of earthworms on crop yield has been studied by a few workers (Kahsnitz, 1922; Hopp and Slater, 1949; Nielson, 1952; Richards, 1955; Stockdill, 1959; Rhee, 1965; Atlavinyte, 1971). Sharma and Madan (1988) assessed the effect of organic wastes alone and in combination with earthworms on plant growth. Maize and wheat were obtained with 2% poultry waste, 2% poultry waste along with earthworms, 2% cattle dung and 2% cattle dung along with earthworms. Highest yield was recorded with poultry waste at the 2% level. Rajkhowa et al., (2000) observed that the application of vermicompost produced large number of nodules in green gram.
Improvement in seed yield of black gram and increase in number of primary branches due to vermicompost application, pods and seed yield per plant was reported by Singh et al. (1999).

A field application of black gram was conducted by Sharma et al. (2000) during Kharif season of 1997-1998. Application of nitrogen and *Rhizobium* inoculation significantly increased the plant height and yield of black gram.

The cultivation of tuber crops with organic manures improved the water and nutrient holding capacity (Mohankumar, 2000). Response of cassava to organic manures was studied by several workers (Mandel et al. 1973; Saraswat and Chettiar, 1976; Mohankumar et al. 1976).

Bharde, et al. (2003) studied the effect of biogas slurry and neem oil treated urea sources on rice (*Oryza sativa* L) and wheat (*Triticum aestivum* L). They found that the application of biogas slurry resulted in a significant yield increase in both the crops.

A pot culture experiment was undertaken by Yadav and Vijayakumari (2003) who evaluated the effect of vermicompost alone and in combination with different organic manures (FYM, composted coir pith, composted press mud, composted sugar cane trash, biofertilizer, green manure and neem cake) and inorganic fertilizer on the biometric and yield parameters of chili. Vermicompost alone and admixed with FYM, green manure, neem cake and NPK were found to be effective in improving various biometric parameters. They observed better yield parameters in vermicompost treatment.

Chitdeshwari and Poongothai (2004) reported that the application of Zn, B and S showed a substantial yield increase of groundnut. Jat and Ahlawat (2004) evaluated the effect of vermicompost, biofertilizers (*Rhizobium* and phosphate solubilizing bacteria)
and phosphorous on chick pea (*Cicer arietinum*.L). They observed that the application of vermicompost resulted in higher dry matter, leaf area index, pods, seed and straw yield of chick pea.

Lopez-Hernandez *et.al.* (2004) found that the fertilization of the soil with organic manures for more than 25 years increased the physical, chemical and biological activity of the soil. Based on their study, they recommended the organic amendments for sustaining agriculture.

Sujathamma *et.al.* (2004) reported that the application of 50 % green manure nitrogen and 50% FYM nitrogen to preceding rice crop resulted in the highest total dry matter, pods, pod weight, shelling percentage, pod and kernel yields, haulm yield as well as nitrogen uptake of groundnut.

Vasanthi and Subramanian (2004) found the effect of organic manures (vermicompost and FYM) and fertilizer on the uptake of nutrients and crude protein content in blackgram. They also reported that the highest crude protein, N, P and K concentration and uptake were recorded in the treatment that received vermicompost along with the recommended levels of N, P and K.