INTRODUCTION
Waste has been a part of human activity from time immemorial. In earlier time, population was small, needs were few, and resources were abundant, the generation of waste was such that it got naturally recycled. However, after the industrial revolution, particularly during the recent decades, the resources have been used recklessly and there has been generation of very diverse types of wastes which are often both non-biodegradable and hazardous; and ecosystem cannot absorb them in natural course, thereby affecting its proper functioning and in turn, the stability of biosphere is affected at the global level.

Efficient utilisation of water resources is crucial to agricultural production for meeting the challenge of feeding the ever increasing human population in the third world countries. In India, water resources are limited and are rather insufficient to meet the long-term requirements of agriculture. An analysis of water budget indicates that ultimate utilizable water from all sources is about 100 to 110 million hectare meters. The present utilisation is only about 60 to 65 million hectare meters. This shows that there is a large gap between available water supply and the amount required for intensive cropping. Waste water from domestic and industrial origin is indispensable for meeting the ever increasing demand of water and nutrients, the most important limiting factors of agricultural production.

City sludge, sewage water and industrial organic wastes of varying composition usually find their way in the soils, which are used for cultivation of various crops. Sewage effluents and sludges are the important sources of water, organic matter and plant nutrients for efficient recycling. Sewage effluent has two components: (a) solid portion or sludge and (b) liquid portion or sewage water. The use of municipal sewage sludge and industrial wastes in croplands has become a subject of current interest because of its economic as well as of environmental interest. Several countries notably Japan, and to some extent Holland, Great Britain, Germany, Denmark, China and
U.S.A. are working very actively in the area of recycling of such waste materials.

By proper utilisation of these materials it is possible to conserve the national resources, reduce the cost of production in many cases, solve the problem of pollution and generate some employment. The basic rationale on which the report is based on 'what is waste to one industry may be raw material for anothers'. In India, people have become cautious and taken up serious works for recycling of sewage, sludge wastes.

Sewage sludge is disposed off in several different ways including (1) recycling on cropland by approved methods, (2) incinerating with loss of organic matter and nitrogen while consuming the fuel, and (3) burying in land fill sites, where it will produce methane for many years. Because of present day economics, application of sewage sludge to cropland is becoming a popular method for many cities. But disposal of domestic sewage on land as irrigation has not been widely practised in different countries, primarily because of various problems such as the distance between the collection and treatment facilities of a community and available land area. Secondly, the soil types and varietal specificities of crops also need special considerations with regard to application of a particular sewage as irrigation source. But their disposal to agricultural land has been found to be beneficial as they contain essential plant nutrients which fulfill the nutrient requirement of crops. Land disposal of liquid sewage sludge is attractive because the process represents the final disposal of the material, with someone else generally assuming the responsibility for it after disposal, little capital investment is required, and complex mechanical operation and the use of chemicals is avoided.

The major emphasis has been directed towards the benefits and potential problems that can result from application of municipal sewage sludge on agricultural land. Considerable attention has been given
to determining the chemical composition of sewage sludge produced by different cities so that the application rate recommendations may be based on a valid knowledge of the components of the sewage sludge.

Sewage effluents and sludges contain appreciable amounts of the major, essential plant nutrients like nitrogen, phosphorus, potassium, sulphur, and several micro-nutrients such as zinc, copper, manganese and iron. Both organic and inorganic forms of nitrogen are present in sewage sludge. The major inorganic form is ammonium, which is rapidly converted to nitrates in soils. Ammonium and nitrate are immediately available for plant growth. The application of equivalent amounts of available plant nutrients in either sewage sludge or commercial fertilizer materials results in similar yields. According to 'an action plan for prevention of pollution of Ganga' (1985), utilisation of these manurial matter increases the crop yield substantially, and on the basis of major macro-nutrient content, the per capita contribution of manurial matter can be taken as rupees three per year. Many of the physical properties of soil that enhance plant growth, such as water holding capacity, infiltration, aggregation, and nutrient holding capacity are improved by sludge application to soils.

Intensification of land spreading of the sludges in the areas, where they are produced, however, has raised concern regarding the potential hazards associated with increased accumulation of non-essential, potentially toxic heavy metals in soils and their subsequent uptake by plants growing in such soils. Heavy metals in sludge originated largely from industrial waste water, treated in municipal sewage treatment plants. Transfer of metals from the added sludge to soils and subsequently, to plants that enter the food chain, presents a significant health concern. Among the metals, chromium, iron, lead, and mercury pose relatively small hazards to plants or animals as they are converted to forms, having very low solubility and availability to plants. Manganese may constitute a problem when added to acid soils in which the increased level of soluble manganese could cause phytotoxicity. Although molybdenum is not phytotoxic at elevated levels, repeated
applications of sludges containing large amounts of it may cause problems in animal health if the soils have high pH. The elements of particular concern are copper, zinc, nickel, and cadmium. The ions of these elements are strongly held by all except sandy soils, but they are taken up by plants in greater quantities from sewage sludge treated soils than from untreated soils. In this respect, soils with high contents of adsorbents, including organic matter, and with high pH involve less risk than acid soils with low contents of adsorbents.

Different types of air pollutants from industrial sources, namely, carbon monoxide, sulfurdioxide, nitrogen oxide and hydrocarbons at last comes to soil and ultimately goes to sewer water by rain. The raw sewer water also contains toxic metals such as Cd, Pb, Ni, Cr, etc.. Long-term use of raw sewer water for irrigating crops may cause metal accumulation in soils to such an extent that may become toxic to plants. But the uptake of heavy metals by plants is governed by their concentration in the soil solution.

Sewage effluent contains pathogenic bacteria, viruses, and parasites which causes a public health risk to farm workers and public via the food chain. Odours and associated nuisance create conflicts between urban residence and the farmers of adjacent cropland who could advantageously use the waste.

Many of the land degrading problems are related to waste from the population pressure particularly in urban areas. The refuse from domestic, municipal and industrial wastes, because of its amount and quality, particularly when it contains detergents, water softners, borates, phosphates and other salts become a serious factor of land degradation. The sewage effluent is often used for vegetable production near cities, but it is also becoming a land degrading source because of the industrial wastes, heavy metal discharge, DDT and other pesticides used for domestic, sanitation, and public health purposes.
Hence, for the use of sewage sludge for crop production, the requirement by the environmental protection agencies is that both crop and water quality be monitored. Proper treatment and use of these sewage water and sludge not only help their recycling with low public health risk, but is also a source of irrigation water and manure for crops.

There are altogether seventeen drainage pumping stations in the city of Calcutta; out of them there are eight disposal pumping stations. The most striking point is that the city of Calcutta has no running treatment plant. In the Eastern fringe of the city raw sewage from 'Dry weather flow channel' is extensively used for sewage farming.

Besides primary objectives of disposal of waste and fertilization of land to promote growth of crops, the increasingly important contemporary objectives of land application is treatment and renovation of the applied effluent for the control of surface water pollution attributable to waste water discharge and ground water recharge. Today there is undenying evidence that the soil-plant system or the 'living filter' is a highly efficient renovator of community waste and that the higher plant constituting a major component of the system substantially complements the conventional physical, chemical and microbiological mechanism in the soil mantle. Presently it is well recognised that the land can no longer perform the role of a neglected waste sink, rather the soil-plant system can serve as a receptor of organic and inorganic residues if the design and operation of the methods are based on an understanding of applicable scientific and engineering fundamentals.

Voluminous literature has been accumulated by scientists from various parts of the world on characterisation and utilisation of sewages and sludges in agriculture, including fisheries and forestry. Details are described in the chapter on 'Review of Literature' of this thesis. Unfortunately no systematic and detailed studies are available on Calcutta sewage, particularly its uses and abuses on land and vegetation. Recently questions have been raised regarding the quality of
Calcutta sewage and its impact on soil degradation and chemical pollution of vegetables and ground water, particularly due to heavy metal concentrations. Accordingly an attempt has been made to assess the quality criteria of untreated Calcutta sewage as a source of irrigation and manure vis-a-vis its impact on soil environment and vegetation.