CHAPTER 1

INTRODUCTION
India’s economy mainly depends upon agriculture and 70% population derives their livelihood directly or indirectly from it. Now the challenge is to mobilize and utilize the best of agricultural science and technology, which can be used to enhance productivity the way which globalization affects human livelihood. The impact of future climate change on biosphere and how policy options can be used to foster food security at sub-national, national, regional and global levels. Food security relates to unseeing that all people at all times have physical, social and economic access to sufficient safe and nutritious food that meet dietary needs and food preferences for active, healthy life. From whatever angle we approach food, water and global security. If in the 21st century we are to achieve a sustainable future for everybody that attaining human security is no longer option. It is imperative, it is the key of our survival on earth planet. Hence, today in more interconnected and interdependent world, human security agenda includes food, water, international negotiation, transboundary pollution, mitigation, frostig population and risk management.

We link science, knowledge, policy, management and grassroots actions in ways that will make a real difference to world food security. Certainly our experience to date of global commitment indicating human food insecurity is not encouraging. For example in 1974, the first food conference in Rome declared its goal of eradicating hunger within a decade. Twenty two year later in 1996 at World Food Summit, the goal
was revised to reduce hunger one half by 2015. This same goal was reiterated at the Millenium Summit 2000. At present over 840 million people go hungry every day. Every minute 15 children and 15 adults die due to hunger in developing and poor countries (Option, 2006).

The present population of 6 billion is likely to reach 8 billion and 12 billion by 2025 and 2100 respectively. There are 230 million people who live below the poverty line. The World Bank has estimated that 80% of the world's poor are in rural areas, where the bulk of the people earn the living from farming. The food security depends on the conversion of 'green revolution' into 'evergreen revolution' routed in the principle of ecology, economics, gender, social equity and employment generation. We can enter a millennium of hope if we abandon the old concept of crop centered green revolution and substitute it with a farming system entered evergreen revolution to produce more food from less land.

The grains of cereal crops constitute a major source of energy in the diet of man even in the area where animal products in relative abundance. In addition to cereals being the first and foremost source of carbohydrates grooming population and the scarcity of energy caused an increase in production of cereals over legumes. Cereals constitute a major quantity of the protein in diet, particularly among the weaker section of population who subsist on cereals diet for longer, extend specially in developing countries. Cereal crops like rice, wheat, barley and millets are the staple food for most of the countries in the world and they provide a major source of carbohydrates. Among cereals barley is contemporary to wheat which is staple food after rice in our country.
'Industrial revolution' has brought rapid increase in the production which enhanced G.D.P. (9.5) and extensive usage of non biological material but repudiate pollution in Indian environment. Agrobased Sugar Mills (579) and distilleries (300+) in the country generate press mud, flyash and distillery effluent, respectively. They are causing air, water, soil and ground water pollution (Ali & Dhaka, 1989). The annual byproduct production through sugar industries are 5 million tonnes of press mud, 7.5 million tonnes of molasses and 45 million tonnes of bagasse. Molasses based distilleries produces 2.7 billion litres of alcohol per annum @ 13-15 litre per litre of ethyle alcohol from these distilleries. 4072 million kilo litres spent wash is generated annually which is posing environmental problem and affecting α-β-γ biodiversity (Ali Khan and Yadav, 2007).

Ali Khan et al. (2006a and 2006b) has also studied effects of distillery effluent on river Ganga and its restoration through fertl-irrigation for checking water pollution.

There is a great need to dispose off and recycle the sewage, domestic/municipal garbage and industrial biodegradable waste into compost that will be a boon in combating the pollution problems in the present situation of resource scarcity. Composting being low cost biotechnology is not only an alternative to chemical fertilizer or manure but it is also one of nature's best protective covering to increase the water holding capacity in clay as well as sandy soil, thus, preventing evaporation of moisture. Compost inhibits growth of weeds, enhances soil quality/fertility and encourages healthy root development. Micro-organisms feed on the organic matter provided in
compost and naturally produce phosphorus, nitrogen and potassium which keep the soil in a healthy balanced condition.

Humus is dark colour, crumbly texture and an earthy smell, is originated after humicification which is mixture of colloidal substances with large molecules and complicated structure resisting decomposting and decomposting organisms (Kovacs, 2005). It is necessary to have carbon nitrogen ratio (C/N) approximately 4:1 by volume in it (Masood, 2006).

The 'green revolution' is the outcome of high yielding varieties which are highly adaptive in our Indian condition, fertilizer responsive, non lodging with high tillering capacity. Various microbiological, agronomic and physiological approaches have been adopted to attain the maximum harvest under field condition on the physiological side, vegetation, growth, flowering time, maturity period, chlorophyll content and nitrate reductase activity in the leaves at different stages of growth are considered important factors drought barley crop yield.

India generates annually 25 million tonnes of solid waste, 3.25 million tonnes of agricultural residues, 210 million tonnes of cattle manure and 3.3 million tonnes of poultry manure proper, utilization of these wastes can give many benefits and reduce its accumulations on land. Thereby reducing health hazardous and thus improving environmental quality which also involves quality of human life, apart from the quality of water, soil, air, etc.

After mechanization in Agriculture livestock in India is gradually decreasing biodegradable industrial, house and biomedical waste gain
more and more significance for organic manure. Now the use of organic waste is recognised as stimulant in composting (Howard, 1935). The recycled waste is economical and relieve environment from pollution and several products be made of them with relatively less investment. Compost is a biological decomposition and contributes to the presentation of soil fertility and improve product quality, which is stable free from pathogen and can be beneficially applied to land (Hang, 1993).

Decomposting is a natural process and aerobic condition is favourable than anaerobic one. It depends on the composition of material, simple sugars with small molecule can easily decompose followed by more complicated starches, proteins, glucose and lignin with large molecules under influence of microorganisms. Organic wastes in presence of oxygen breakup to their elements (minralization) energy set free and nutrients are available to plant from compost.

Organic farming is known by different names in different countries as biological farming, regenerate farming and sustainable farming. Rodolf Steins, Australian Social Philosopher, is creator of biodynamic farming. It is also known by the term biodynamic farming. Although strictly speaking, this is part of a whole philosophy that includes education, art, nutrition and religion as well as agriculture.

Organic manure is the most traditional method to protect soil fertility and to increase the crop productivity. Organic farming system is not new in India and is being followed from ancient time. It
protects the soil chemically, physically and biologically which increased usage of chemical fertilizers, damage soil texture and pose threat to micro, meso and macro (earthworms) population dynamics. Organic manure as soil enricher can plays an important role to develop sustainable agriculture. Time has come to change the practice of excessive use of agrochemicals in farming and to compete chemical fertilizers by organic manure and biofertilizers because soil fertility has been deteriorated globally. Thus heavy chemicalization in agriculture has resulted into deterioration of soil fertility pollution of ground water and ecological imbalance. Due to these problems echo of sustainable and ecofriendly agriculture has become louder. The essential feature remaining the same i.e. "back to the nature".

The abundance of nitrogen in the atmosphere (80 %) and soil (78 %) and its non-availability to plant is one of the greatest paradoxes in nature. Nitrogen is the most growth-limiting nutrient for crop in most of the soil of India. Indian soils are poor in nitrogen. Nitrogen and phosphorous are two most vital and growth limiting plant nutrients which are required for successful crop production. Not only this utilization of efficiency of this nutrient by the crop plant is also very low being about 25-30 % of total nitrogen applied. Because these fertilizers are wasted through the process of diversification, volatilization and leaching into soil.

Nitrogenous fertilizer like urea is being used to fulfill its requirement in order to increase the crop productivity. Therefore, demand of chemical fertilizer is increasing day by day to obtain maximum output from different crop plants in intensive agriculture.
However, the production of nitrogenous fertilizer is not only expensive but also a drain on our valuable foreign exchange which has resulted in higher prices and lower supply. Due to hike in the prices of nitrogen fertilizers the need to look for new methods of enriching soil with nitrogen has naturally become an urgent need of the hour and has turned the attention of scientists towards biological nitrogen fixation. Because the fast depletion of non-renewal sources of energy has also led mankind to devise ways and means to rely increasingly on renewal organic sources for enriching the nitrogen content of soil.

Moreover, it has been proved when chemical fertilizers and agrochemicals are used in excessive doses. Fatigue of 'green revolution' which have led to many ill effects on agro systems. The soil would harden with excessive chemical fertilizer as the assertion of soil become poor. Thus nutrients retention capacity would decline greatly. Hence, the plant is to absorb nutrient efficiently no matters how much chemical fertilizers put in.

Consequently, there is stagnation in crop yield even when higher doses of fertilizers are added. Therefore, it is needed to look new sources of nutrients for enhancing sustained management of soil fertility. Under such circumstances the application of biofertilizers which is cheap, non-polluting and non-leaching can be used as safe guard of enhancing the crop production with effective cost benefit ratio and for sustainable agriculture.

Biofertilizers can meet this challenging task in most economical and eco-friendly manner. These are natural fertilizers more
appropriately called microbial inoculants consisting of living cells microorganism like bacteria, algae and fungi alone or in combination. These microorganisms help in increasing crop productivity by way of fixing atmospheric nitrogen and solubilizing insoluble phosphate fertilizer to keep sustainability of soil fertility. Nitrogen fixation in the rhizosphere of grasses and non-leguminous crop was indicated sometime ago.

With the introduction of new technologies, the modern agriculture is getting more and more dependence upon the steady supply of synthetic inputs (mainly fertilizers) which are products of fossils fuel (coal and petroleum). Excessive dependence of modern agriculture at the supply of these synthetic inputs and the adverse effects being noticed due to their excessive and imbalanced use has compelled the scientific fraternity to look for alternative.

Sustainable agriculture is a new paradigm, is introduced it is a new way to consider whole of the agriculture in relation to environment and efficient use and management of natural resources. Sustainable agriculture is a philosophy based on human goals and on understanding the long-term impact of our activities on the environment and on other species. Use of this philosophy guides our application to prior application and latest scientific advances to create integrated resource conserving, equitable farming systems. These system reduce environmental degradation maintain agricultural productivity, promote economic viability in both short and long term and maintain stable rural communities and quality of life for food security and ecosystem services for 6 billion people on the earth (Agarwal, 2003).
Green revolution, instrumental in tripling India's food production since independence, gave importance to large quantities of fertilizers. The uninterrupted and improportionate use of chemical fertilizers over a long period of time since 1960 has resulted in loss of soil fertility, removal of soil organic matter and accumulation of salts, heavy metals and contamination and toxification of food, fodder and water, organic manure such as composts, farm yard manure, green manure biofertilizers, press mud etc. are the important sources to increase the soil organic matter content, soil microflora population (Christopher and Launduraj, 2002).

Sugar and distillery discharge huge quantities of solid and liquid wastes. The conversion of these wastes as compost provides a sound solution for their disposal and helps in meeting the mineral requirement, besides sustaining soil health management by maintaining oil organic status and reducing considerable the problem of environmental pollution (Ali Khan and Ahmed, 1998; Ali Khan and Kashyap, 2007; Ali Khan and Yadav, 2007 and Ali Khan et al., 2007). Thus continuos application of inorganic fertilizers had reduced profitable cultivation of crops apart from affecting soil properties. However, conjunctive use of organics and inorganics was found to be more beneficial not only in sustaining the yield but also maintaining soil productivity at higher level.

Biofertilizers are the organisms that directly or indirectly supply nutrients for the growth of crops. Biofertilizers organic manure and biological control of pathogen on serve tools in hand, to develop backbone that could be ecologically sound, environmentally friendly
and economical viable for productivity and sustainable by way of increased nitrogen fixation availability of nutrients through solubilization or increased asorption stimulation of plant growth through harmonal action or antibiosis and decomposition of organic residues. The role of biofertilizers in sustainable crop production has been studied (Biswa et al., 1985; Wani and Lee, 1992 and Katyal et al., 1994). Bio-agrofertilizers are able to coordinate the acidity of the soil, improves the root system of crop and soil structure and maximize the nutrients uptake and thus would healthier the plant growth to gain a remarkable higher yield. These are reacy to use live formulates of such beneficial microorganisms which on application to seed, root or soil mobilize the availability of nutrients by their biological activity in particular and help to build up the microflora and in turn the soil health in general.

Microbial strains are *Azospirillum* spp., *Rhizobium* spp., phosphate solubilizing bacteria (*Bacillus polymyxa*), *Lactobacillus* spp. *Nitrifying bacteria*. Photosynthetic bacteria series, year group series and actinomycetes. The combination of these essential bacteria with their unique functions would secret the nutrients into the forms that are readily utilized by crop for healthier growth and soil health management.

Bio-Agrofertilizer (biofertilizers) would duplicate extensively, increase the viability and growth kinetics of soil microbes with cation exchange capacity (CEC) the microbes are able to coordinate the pH value. The compactness and hardness of soil would improve with the luxuriant growth of roots and thus improve the soil structure.
Nitrogenous biofertilizers harvest atmospheric nitrogen and convert into ammonical form which in due course is made available to the plants or is released into the soil. Phosphate solubilising bacteria (PSB) solubilize fixed forms of phosphorus already present in the soil and make it available for use of plants. Composting biofertilizers are used for harvesting the process of composting and for enhancing its nutrient value.

Biological nitrogen fixation (BNF), the biological conversion of atmospheric nitrogen into N, is most important alternative. BNF plays positive and constructive role in maintaining soil N. In the ‘post green revolution’ era, intensive cropping, excessive N fertilizer use and maximum output with minimum input has deteriorated soil health. So, it needs judicious use of chemical fertilizers in combination with use of efficient, effective and competitive Rhizobium and other nitrogen fixing inoculants (Pathak et al., 1997). Active research on the use of non-symbiotic bacterial inoculant was initiated by a member of soviet scientists from 1932 to 1942 in Azotogen. Commercial preparation of Azotobacteria chroococcum was used in 5 million acres of crop. East agriculturist also performed same trials and so did the Indian workers.

The beneficial effects of a symbiotic nitrogen fixer Azospirillum has gained much importance in many crop plants especially in cereals after the discovery by Dobereiner and Day (1974). Azospirillum was earlier described as Spirillum lipoferum. Evidence for presence of Azospirillum colonizing the above ground portion of plant apart from the roots is also available (Kavinandan et al., 1978 and Tilak and
Murty, 1981). The *Azospirillum* root associations led to increased yield in cereals and forage grasses (Tilak and Shuba Roa, 1987). The high efficiency of N-fixation combined with low energy requirement, easy establishment of plant roots and tolerance of high soil temperature exhibited by *Azospirillum* to make it ideally suited for cereal crops under tropical condition. Field experiments have been laid out by IARI scientists on the use of this organism on crop like rice, wheat, barley, sugarcane, sorghum, ragi and other minor millets (Tilak and Murty, 1983 and Subba Roa, *et al.*, 1985). The plants inoculated with *Azospirillum brasiliense* yielded better due to better root development (Panwar and Sirohi, 1989, Panwar *et al.*, 1990) arranging more water and nutrient uptake (Panwar, 1991, 1993).

*Azospirillum* has high nitrogen fixing capacity. Field experiments have proved that as much as 0.5 Kgs. nitrogen could be fixed in one day per hectare of land devoted for the cultivation. It helps to enhance the yield of bajara (23 %), ragi (40 %) cotton (15-30 %) and sorghum (18-22 %). Therefore, recommended for low cost technology. It saves 20-30 Kg. N. per hectare.

Phosphorus is also an important primary plant nutrient which helps root formation and plant growth and thereby better yielding. The phosphorus of majority of Indian soil is generally quite low which hinders high crops production. Hence the heavy dose of phosphatic fertilizers in the available form is essential for better crop yield under intensive cultivation.

The continued application of phosphatic fertilizer led to adverse effect on soil environment which causes adverse effect on
agroecosystem and eutrophication in aquatic ecosystem. Moreover the utilization of efficiency converted into fixed and insoluble unavailable form of phosphorus. There is also shortage of phosphate fertilizer and the cost of its production has increased substantially during the recent years as it involves foreign exchange for import of raw material such as good quality of rock phosphate, sulphur, phosphoric acid and sulphuric acid. Therefore, the economic use of the fertilizers receives attention to recycle the fixed and insoluble unavailable form in soils with the use of phosphate solubilizing bacteria (PSB). So as to make available for utilization of crop inoculation of seed can solubilize applied phosphate varying from 40-50 Kg P₂O₅/h.

The phosphate solubilizing microorganism mainly are bacteria (Bacillus polymyxa - B. subtilis, Pseudomonas strita) and fungi (Aspergillus awamori, Penicillium aligitatum). The use of Bacillus subtilis (PSB) has been reported to enhance seed yield under field condition in sunflower and other crops (Malik et al., 1995). Timmusk and Wagner (1998) studied that inoculation of Paenibacillus polymyxa (Bacillus polymyxa), PGPR (Plant Growth Promoting Rhizobacteriuan) suppressed several plant pathogens and direct competition for nutrients in plausible scenario and protected Arabidopsis thaliana against bacterial pathogen and drought stress in a genobiotic system.

The Simbhaoli Sugar Mill Limited, Simbhaoli (Ghaziabad) was established in 1933 on NH-24, 75 km north-east of Delhi. It is one of the 579 sugar mill and sugar manufacturer in Northern India. Later on Simbhaoli Distillery Division was started across Railway Station
adjacent to R.S.K. Inter College and Kisan (P.G.) College, Simbhaoli. Since then hazardous D.S.W. was discharged into Kutcha lagoon for anaerobic degradation and solar drying. Which has caused soil, air and ground water pollution in the vicinity (Ali Khand, 1990 and Ali Khan and Dhaka, 1996). Industrial wastes (solid or liquid) are either discharged to water reservoir or in land filling, contaminated the environment. However, these wastes contain considerable quantities of nitrogen, phosphorus, potash and micronutrient which might be assimilated into soil for agricultural crops. SOM (Simbhaoli Organic Manure is being manufacture from press mud, flyash and spent wash after Ch. Charan Singh Compost (Ali Khan and Kashyap, 2007).

Cultivated barley (*Hordeum vulgare* L.). Family Poaceae is descended from wild barley (*Hordeum spontaneum*) which still grows wild in the middle east. Both forms are diploid (*2n = 14 chromosomes*). The first domesticated barley has been found in the *Aceramic Neolithic* (PPNB) of Tell Abu Hureya in Syria. It is thought this grain made its way to North America with Christopher Columbus on his way journey to the new world. Paleoethnobotany has found that barley has been grown in Korean peninsula since the early mumun pottery period (1500-850 B.C.) alongwith other crops such as millets, wheat and legumes.

Barley being one of the most important cereal of subtropical world is preferred to wheat under adverse condition of soil, water and climate. It is a drought crop and more tolerant to soil salinity and sodicity. In Rajasthan, U.P., Punjab and M.P., it is grown both irrigated and rainfed crop in light texture soil, low in organic matter,
nitrogen, phosphorus and sulphur. It is grown in tropical and temperate areas in Australia, Canada, European Countries (EU), Soviet Union, Middle East, North Africa, India and United States of America (USA). Egyptian and Greeks in ancient times consumed barley for medicinal purposes as well as for nourishing food sources.

Barley is a major stable food for human (contemporary to wheat) but primarily used for animal feed. It is fed to beef, cattle, dairy cattle, swine and poultry. Barley's second most important use is for malt that soon ferments and slightly alcoholic malt is used for beer, liquor, malted milk and flavouring in variety of foods. Malt is produced by germinating barley under controlled condition. Barley flour is an ingredient in nearby all baking flours that are used to make breads and other baked goods-porridge soups, snack bars. Drinking of conception of barley and sugar is generally used for relieving 'heatiness' (sattoo) in the body in Asia and China. A cup full of barley boiled with 20 cups of water together with screwpine (Pandon) leaves gives a delicious and cooling drink in place of coke, etc. In Japan, barley tea is called mugicha and in Korea-boricha, Caffi’d’orze is an espresso or coffee style drink from roasted barley in Italy. It is sold as 'Postum', 'Peru' in USA and Cafe de cebada in Latin America Market. In this response barley (Hordeum vulgare L.) occupying an important place in food supply as it ranks next to wheat, rice and maize. It is used for both human and animal feed. It is also used in malt industry. It is apparent that sustainability of crop production system in future will mainly depend on integrated nutrient management and balance supply of nutrient i.e. judicious application
of inorganic nitrogen along with organic and biological sources (Tripathi and Tiwari, 2007). Therefore, it is important to explore an alternative to chemical fertilizers that can be used by farmers-organic manures like SOM green manure, farm yard manure (FYM) and biofertilizers may be used for this purpose.

In view of the above present investigation has been taken to study the role of biofertilizers microorganism (*Azospirillum, Bacillus polymyxa*) and SOM (Simbhaoli organic manure) (Press mud + Flyash + Distillery Effluent) for increasing the soil fertility and productivity of crop for environment conservation with the following objectives:

**OBJECTIVES**

1. Physicochemical analysis of SOM (Simbhaoli Organic Manure).
2. To study the effects of organic manure (SOM) and biofertilizers (*Azospirillum brasilense* and *Bacillus polymyxa*) on the growth and yield of *Hordeum vulgare* L.
3. To observe sustainable impact of organic manure, farm yard manure (FYM) and biofertilizers on soil fertility.