**Agriculture (Biofertilizers)**

The plants are unable to use gaseous nitrogen present in the atmosphere or sulphur or phosphorus present in soil. Such essential elements are to be mineralized for consumption by the plants. There has been growing trend of using organic manures along with nitrogenous fertilizers in various part of world to increase soil fertility. Such organic manure are called **biofertilizers**. The biofertilizers do not directly increase soil fertility but they initially initiates or accelerate the process of mineralizations. Some interesting results have been experienced in this direction of biofertilizers use. This has resulted in mass production of *Rhizobium*, *Azotobacter*, *Azospirullum*, phosphate solibilizing bacteria, cyanobacteria and organic matter of decomposing microorganisms.

Some important bacterial biofertilizers used in agricultural practices are

1. Rhizoidal biofertilizers : The most important and the best studied nitrogen fixing symbiotic association is between *Rhizobium* spp. and various leguminous plants. *Rhizobium* occurs free living in the soil but does not fix nitrogen in this state. It is recently proved that they can fix nitrogen in laboratory condition in the absence of the host, when supplied with carboxylic acid, pentose and small amount of fixed nitrogen.
2. *Azotobacter* biofertilizers : Mass production of *Azotobacter* to inoculate soil or seeds for sufficient increase in the yield were made for the large scale application on Russian farms. Upto 20% increase was claimed for a wide variety of important crops and this was assumed to be due to nitrogen fixation. Many of the yield increases have been substantiated by using *Azotobacter* in all plants of the world, particularly when something less than the best seed was used.
3. Potential of *Azospirullum*, *Beijerinckia* and *Rhodospirullum* as biofertilizers has been exploited so as these could serve an alternative to chemical fertilisers.
4. Mycorrhizae, both ecto and endo-mycorrhiza help in uptake of N,P,K and Ca. They particularly help in phosphorus nutrition.
5. New nitrogen fixers : through recombinant DNA technology efforts have been made to introduce nitrogen fixing genes (nif genes) into wheat, corn, rice etc. plasmids of bacterium , E.coli and yeast are being worked out for such a possibility. Hybrid E.coli plasmid cloned with nif genes of a nitrogen fixing bacterium, *Klebsiella* pneumonia and hybrid yeast plasmid are then integrated.
6. Cyanobacterial biofertilizers : several cyanobacteria such as *Aulosira, Anabaena, Nostoc, Plectonema, Scytonema, Tolypothrix*  etc. are very good nitrogen fixers. In suitable conditions, for example, on the surface of bare moist earth in the tropics, they may add valuable amounts of nitrogen to the soil. Unlike nitrogen fixing bacteria these organisms can photosynthesize and so need no external supply of carbon compounds.
7. Besides these some cyanobacteria (*Anabaena azollae*) are known to undergo symbiotic association with grasses and pteridophytes and fix considerable amount of nitrogen. The water-fern *Azolla* containing nitrogen fixer Anabaena is being currently used in rice cultivation.
8. Phosphate solubilising microorganisms : some bacteria e.g. *Thiobacillus*, *Bacillus* etc. convert nonavailable phosphorus present in soil into an available from utilizable by crop plants.
9. These bacteria also produce iron chelating substances, e.g. *Psedobactin*, called siderphores which chelate the iron present in root zone. As a result, this iron becomes nonavailable to harmful microorganisms and in this manner crop plants are protected from them.

**Advantages and limitations of biofertilizers**

The relevance of biofertilizers is increasing rapidly since chemical fertilizers

1. Utilize petroleum (nitrogenous fertilizers)
2. Are costly
3. Are short in supply
4. Damage the environment.

In contrast biofertilizers are

1. Low cost inputs
2. Lead to soil enrichment
3. Are compatible with long-term sustainability.
4. They are ecofreiendly and pose no danger to the environment. However, the acceptiability of biofertilizers has been rather low chiefly because they do not produce quick and spectacular responses. In addition, the amount of nutrients provided by them is not enough to adequately meet the total needs of crops for high yields. Therefore, a pragmatic approach more likely to succeed will be to develop a rational and effective combination of biofertilizers and conventional fertilizers for optimum crop yields.