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BIOFERTILIZERS : SCOPE AND IMPORATNCE

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According to an estimate 240 million tones of food grains will be required to feed about one billion expected population by 2000 AD in India and to achieve this milestone, a sizable quantity of mineral fertilizer will be required. The total fertilizer requirements of our country would be 23 million tones as against the present consumption level of 13 million tones, which is beyond any single type of nutrient source to accept the challenge of appropriate nutrient supply. Integrated use of all the sources such as mineral fertilizers, organic manures, biofertilizers etc. is the only alternate for improving soil fertility.

It has now become possible to meet a large part of our total nitrogen demand through proper husbandry of biological nitrogen fixation by micro-organism in crop production system. Bio-fertilizers are capable of providing an economically liable level for achieving the ultimate goal of enhanced productivity. The crop microbial soil ecosystem can, therefore, be energized in sustainable agriculture.

India is fourth largest user of chemical fertilizers (12.5 million tones of NPK nutrients) in the world even its soils are still being depleted of their inherent nutrients reserve as a result of wide gap between additions (12.5 million tones) and removal (18.5 million tones). One tone of produce removes an average of 32 kg nitrogen, 12 kg phosphorus and 58 kg potash. The strategy for sustaining satisfactory yield levels envisages nutrient balance and efficient nutrient cycling. This can be successfully achieved through integrated use of mineral fertilizer, bulky organic manures, compost, green manure, biological inoculant etc. At present, the nutrient use in India is much less compared to that of other countries. Against world average consumption of 95 kg ha^{-1}, and we are using 74 kg ha^{-1} with national productivity level of merely 1.1 metric ton per hectare.

At present India produces about 117 million metric tones of food grain for its growing population of more than 800 million people. Nitrogen fertilizer plays prominent role in increasing this food requirement. At present the vast gap cannot be filled up merely through the production of synthetic nitrogen fertilizers due to scarcity of high cost of raw materials such as fossil fuels. Biological nitrogen fixation is the key to sustain agriculture productivity application of biofertilizer in the field is the liable alternative.

In fertilizer manufacturing factories, nitrogen is fixed industrially, by means of the Haber Bosch process requiring H_2 gas, very high temperature and enormous energy. Industrially fixed nitrogen has been used precipitously. It was produced 4.0 lakh metric tones in 1905 and this was increased to 3.5 million tones of nitrogen fertilizer. However, above every hectare of land, there are 78,000 tonnes of inert nitrogen gas (N_2). As nitrogen is the most limiting nutrient for increasing crop productivity. Only a few prokaryotic organisms are able to fix nitrogen directly through a biological process. Annual biological nitrogen fixation (BNF) is estimated to be around 175 million tones of which close to 79 % is accounted for by terrestrial fixation.

Table 1: Estimates of nitrogen fixed by some legumes

Sr. No.	Crops	Nitrogen fixed (Kgha^{-1})
1.	Alfalfa	100-300
2.	Barseem	120-150
3.	Chickpea	26-63
4.	Clusterbean	37-196
5.	Clover	100-150
6.	Cowpea	53-85
7.	Blackgram	38-50
8.	Greengram	50-55
9.	Groundnut	112-152
10.	Lentil	35-100
11.	Peas	59-80
12.	Pigeonpea	60-200
13.	Soybean	49-130
14.	Sesberia	69-90

The term biofertilizers or which can be more appropriately called 'microbial inoculants' can be generally defined as a preparation containing live or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulytic microorganisms used for application of seed, soil or composting areas with the objective of increasing the number of such microorganisms and accelerate certain microbial process to argument the extent of the availability of nutrients in a form which can be easily assimilated by plant. In large sense, the term may be used to include all

Table 2 : Important micro organisms constituting biofertilizers	
Microorganisms	Nutrient fixed (kg /ha /year)
Actinorrhizae (Frankia sp.)	150 kg nitrogen /ha
Algae	25 kg N_2 /ha
Azolla	900 kg N_2/ha
Azospirillum	10-20 kg N_2/ha
Rhizobium	50 to 300 kg N_2/ha
Azotobacter	0.026 to 20 kg N_2/ ha
Mycorrhizae	Solubilize food phosphorus (60 %)
Phosphate solubilizing bacteria and fur	Solubilize about 50 – 60 % of them fixed phosphorus in the soil.

organic resources for plant growth, which are rendered in an available form for plant absorption through microorganisms or plant associations or interactions.

Soil harbours a range of microorganisms, which bring about a number of biochemical reactions in soil. The soil organisms are classified into two broad groups i.e. soil flora and soil fauna, they are again subdivided, depending upon their size such as micro and macro flora. Soil microflora includes bacteria, fungi, actinomycetes, algae etc. of these groups, bacteria are the most abundant followed by actinomycetes and fungi; algae are found under specific situation. The biomass and population of these micro-organisms in soil have been given in Table 3.

Table 3: Biomass and population of micro-organisms in soil

Sr. No.	Microorganism	Average number (in lakhs) per g of soil	Average biomass (in kg per ha)
1.	Bacteria	1000	500
2.	Fungi	10	1000
3.	Actinomycetes	100	750
4.	Algae	0.01	150

The presence of these microorganisms make the soil a living and active system. These microorganisms play a significant role in the life cycle of plants and animals through a number of process such as decomposition, solubilization, nutrient fixation and supply of plants.

At present, in India there is a gap of about 10 million tones of plant nutrients between removal by crops and replenishment through fertilizers. Supply of nutrients from organic manure has not so far been able to fill up this gap and also in years to come nutrient supply form the source is unlikely to improve due to competitive demand for alternate uses like fuel and fodder. Of late, biofertilizer are being promoted as an important component in supplementing plant nutrient need of the country.

India is one of the important countries in biofertilizer production and consumption in the world. The present production capacity of different production units in the country is about 4500 tonnes per annum. The maximum production capacity is in Agro Industries Corporation followed by State Agriculture Departments, National Biofertilizer Development Centre, State Agriculture Universities and private sector. Among the different states, the maximum production capacity is in Tamil Nadu followed by M.P. U.P., Gujarat and Maharashtra.

Thrust in Research and Development: The rising cost of chemically fixed nitrogen fertilizer and the massive inputs of non renewable resource will be devastating. As an alternative there is urgency of major research effort in biological nitrogen fixation. Nitrogen in the form of ammonia is used by plants and microbes as a building block for the synthesis of amino acids and of other nitrogenous compounds. The conversion of atmospheric Nitrogen into ammonia by the nitrogen fixing microbes, mostly certain bacteria and blue green algae is called biological nitrogen fixation. Although leguminous plants have been used extensively in agriculture for centuries, it is possible to exploit these nitrogen fixing plants meaningfully. The use of new leguminous crops as well as the breeding of more vigorous and effective traditional leguminous crops can be helpful in food production. As the bacteria are the agents of fixation in bacterial plant Rhizobial technology and soil microbiology are the neglected areas. It would be a right type technology that all farmers could use legume – Rhizobial combinations constitute, a built-in nitrogen source for food crop production. Approximately 75 per cent of the nitrogen utilized by legume comes from the soil, with only 25 per cent from BNF. It is necessary to increase the rate of nitrogen fixation achieved, which would have a multiplier effect on the enhancement of crop productivity.

Chemical fertilizers have temporary effect while biofertilizers have permanent effect without any production problem. Use of composite biofertilizers have permanent effect without any production problem. Use of composite biofertilizers can increase soil fertility. The cost is too much low for the biofertilizers and its proper use dose not only include a correct application of the inoculant to the seed soil but also good. Considering the prospects of biofertilizers in the country, the biofertilizers development centres are being established both in government and private sectors and It is only possible by establishing joint venture in biofertilizer agro based industry.

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