Role of Biofertilizers in Sustainable Agriculture- Prospects and Constraints

Bandana Mayanglambam¹, Bijeeta Thangjam², Naorem Meena Devi³

¹Dept. of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal (741 252), India
²Dept. of Plant Pathology, College of Agriculture, CAU, Imphal, Manipur (795 004), India
³Dept. of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal (741 252), India

Biofertilizers are low cost, renewable source of plant nutrients which supplement chemical fertilizers. It is used to provide nutrition to plants in a sustainable or ecofriendly system. Technically, biofertilizers are identified as plant extract, composted urban wastes, and various microbial mixtures with unidentified constituents, which provide inexpensive source of plant nutrition. More importantly, biofertilizers can be composed of efficient microbial strains that, by their interactions in rhizosphere, benefit crop plants by uptake of nutrients. So basically, biofertilizers are selected strains of beneficial soil microorganisms cultured in the laboratory and packed in a suitable carrier. They can be used either in the form of seed treatment or soil application.

Types of Biofertilizers

1. Nitrogen-fixing Biofertilizers- Certain microorganisms present in the soil are capable of considerable nitrogen fixation. This property allows for the efficient plant uptake of the fixed nitrogen and reduces loses by denitrification, leaching and volatilization from the soil. These microbes can be-
   a) Free living in the soil- Example- Anabaena, Azotobacter, Klebsiella, Nostoc, Rhodospirillum, Clostridium, Chromatium, etc.
   b) Symbiotic- Having symbiotic and other endophytic associations with plants. Example- Rhizobium, Bradyrhizobium, Sinorhizobium, Frankia, Anabaena azollae, etc.
   c) Associative- These nitrogen fixing microbes have less intimate association with roots in comparison with symbiotic microbes. Example- Azospirillum sp., Acetobacter diazotrophicus, Alcaligenes, Bacillus, Enterobacter, Pseudomonas.

2. Phosphate Solubilizing Biofertilizers (PSB)- Many Phosphorus solubilizing bacteria (PSB) like Bacillus and Pseudomonas and certain soil fungus like Aspergillus,
4. Plant growth promoting Biofertilizers- These are Phosphate mobilizing biofertilizers or phosphate absorbers. Example- Arbuscular mycorrhiza, ectomycorrhiza, ericoid mycorrhiza, orchid mycorrhiza.

5. Other Mineral-Solubilizing Biofertilizers- Used to provide various nutrients other than Nitrogen and Phosphorus such as Potassium, Zinc, Iron and Copper. Example- Bacillus edaphicus, Paenibacillus glucanolyticus, etc.

Advantages of Using Biofertilizers In Agriculture

1. Low cost and easy application technique- Biofertilizers are cost effective relative to chemical fertilizers. They differ from chemical and organic fertilizers because they don’t directly supply any nutrients to crops and constitute cultures of special bacteria and fungi with relatively low installation cost. They have lower manufacturing and reduced use costs, especially regarding Nitrogen and Phosphorus use. The way of it’s application is easy and consumes smaller amounts of energy.

2. Provision of Nitrogen and several growth hormones- Nitrogen fixing microorganisms play an important role in nitrogen supply by converting atmosphere nitrogen into organic forms usable by plants which can contribute to a decrease in the nitrogen fertilizer application and to the reduction of environmental risks. In addition to this, they have the ability to synthesize and secrete considerable amounts of biologically active substances such as vitamins like thiamine, riboflavin, biotin, etc. which can help in modification of the nutrient uptake by the plants. Some microbes also produce plant growth hormones heteroxins, gibberellins.

3. Do not cause atmospheric pollution but increase soil fertility- The use of biofertilizer augments the problem of environmental pollution. Biofertilizers promote the reduction of excessive use of chemical fertilization. Thus, their use in organic farming and non-pollution farming contribute to implementation of healthy environmental policies at regional, national and global level. Continuous use of biofertilizers enables the microbial population to remain and build up in the soil and helps in maintaining soil fertility contributing to sustainable agriculture.

4. Excretion of antibiotics and acting as pesticides- The use of biofertilizers can promote antagonism and biological control of phytopathogenic organisms. Thus positive effect on soil microbiology is exerted. Through siderophores and antibiotics produced by them, biofertilizers have antagonistic effect to foliar or rhizosphere pathogenic bacteria, fungi and insects.

5. Improvement of physical and chemical properties of soil- Biofertilizers contribute to better physical conditions of the soil through improvement of structure and aggregation of soil particles, reducing compaction and increasing the pore spaces and water infiltration. They allow better tilth; ensure better soil aeration and water percolation, reducing soil erosion. The maintenance of good soil structure in all ecosystems is largely dependent on mycorrhizal fungi.

6. Enhance crop yield even under ill irrigated conditions- Biofertilizers increase the water and nutrient holding capacity of the soil and also increase the drainage and absorption of moisture in soils, especially in those with structural deficiencies or lack of nutrients. They increase the tolerance towards drought and moisture stress. In this way, they increase the crop yield even in plantations that lack sufficient water supply or irrigation.

7. Eco-friendly and pose no danger to the environment- The most important and contributing function of biofertilizer is improvement of agro-ecological soundness. Biofertilizers are eco-friendly organic agro-input compared to chemical fertilizers. Due to this attribute, the demand for biofertilizers is on the rise during the last decade.

Some Factors Limiting the Use of Biofertilizers:

1. Lack of regulatory acts and facilities for testing the samples- Future research on biofertilization should be focused on identifying the options available to tackle the issues and offer valid frameworks for development of environmentally friendly practices that allows improvements on the efficiency and consequent supply of product for the industry in the global economies. What is more, technical tests must be carried out to verify their safety at global scale.

2. Insufficient popularization of Biofertilizers and low level of farmer acceptance- In spite of having various potential activities, biofertilizers have not yet gained popularity among farmers for adequate acceptance. The lack of awareness of the farmers about the concentration, time and method of biofertilizer application, about the efficiency of biofertilizer compared to their familiarity with the use of conventional inorganic fertilizers is serious limitation of their wide-scale application. Other problems such as lack of timely availability of financing, lack of guidance from experts, non-availability of biofertilizers also hinder the acceptance of biofertilizer.

3. Possible risks for the safety of consumers and the physicochemical and biological stability of soils- The presence of manure could increase the amount of weed flora. The presence of heavy metals (e.g., Mercury, Chromium and Lead) poses a threat due to their carcinogenic potential and their capability of bio-accumulation and bio-magnification in the food chain. For this reason, use of manure should be well assessed.
Constraints in Biofertilizer Production Technology

1. **Technological constraints**
   a) Use of inappropriate, less efficient strains for production
   b) Inadequate and inexperienced staff and not technically qualified personnel
   c) Quality of carrier material
   d) Shelf-life of inoculants

2. **Infrastructural constraints**
   a) Facilities for production
   b) Equipment
   c) Laboratory, production, storage space

3. **Financial constraints**
   a) Funding
   b) Sale returns

4. **Physical and environmental constraints**
   a) Seasonal demand for biofertilizers
   b) Soil characteristics
   c) Cropping operations

Future Perspectives of Biofertilizer

Uncontrolled over-application of chemical fertilizers by farmers during intensive agricultural practices has led to excess nutrients accumulation in soils, which, as a result, makes the soils dead. That is why, nowadays, the production of efficient and sustainable biofertilizer wherein inorganic fertilizer application can be reduced significantly to avoid further pollution problems, represents major research interest.

The most important and specific research needs should highlight following points:

1. Selection of effective and competitive multi-functional biofertilizers.
2. Quality control systems for production of inoculants and their field application.
3. Study of microbial persistence of biofertilizer in soil environments under stressful conditions.
4. Transferring technological know-how on biofertilizer production to the industrial level.

**Conclusion**

In modern day agricultural practices, biofertilizers form an important component of sustainable organic farming in terms of a viable alternative of chemical fertilizers that are associated with various environmental hazards. However, an increased demand and awareness among farmers and planters about the use of biofertilizer needs to be created to popularize its status. Biofertilizer technology which is an inalterable part of sustainable agriculture, has to be appropriate for the social and infrastructural situations of the users, economically feasible and viable, renewable, applicable by all farmers equally, adaptable to existing local conditions and acceptable by various cultural patterns of society, practically implementable and productive.

**References**
