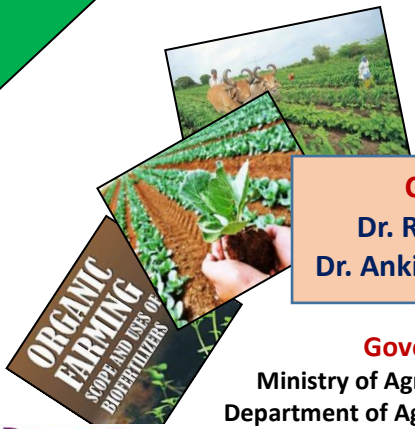
Usage of Biofertilizers & Organic Fertilizers & Their Recommendations to Farmers



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- Organic Inputs (Biofertilizers & Organic fertilizers)
  - Replace chemical nitrogen and phosphorus by 25%
  - Restore soil fertility and build-up organic carbon
  - Stimulate plant growth and increase crop yield by 20-30%
  - Helpful in providing protection against drought and some soil borne diseases

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Role of Organic Inputs in Organic Farming: In organic farming, the first step is to build up the fertility of the soil and it can be achieved with the use of organic inputs. In the promotion of organic agriculture various types of organic inputs including biofertilizers and organic fertilizers have been launched and are being sold to farmers. This handout provides an easy to follow guide describing the process of the usage of various biofertilizers and organic fertilizers and their application & straightway recommendations to the farmers in order to expand their scope in the agriculture.

I. Biofertilizers - Biofertilizer means the product containing carrier based (solid or liquid) living microorganisms which are agriculturally useful in terms of nitrogen fixation, phosphorus solubilization or nutrient mobilization, to increase the productivity of the soil and/or crop.

1. N_2-Fixing biofertilizers: These biofertilizers are composed of microorganisms which are able to fix atmospheric nitrogen and convert it into plant usable form. They are of different types as describe below:

1.1 Rhizobium: It lives symbiotically in the root nodules of leguminous plants and supply nitrogen to the plant through nitrogen fixation. Specific Rhizobium strains inoculated in crops contribute in 10-30% increase in crop yield. Besides that, nitrogen fixed by legume-Rhizobia association also leave residual nitrogen for the succeeding crops[1].

These biofertilizers are crop-specific and fix nitrogen as mentioned below:

Leguminous crop Root Nodules Rhizobium culture

Quantity of biological N fixed by Liqiud *Rhizobium* in different crops

Host Group	Rhizobium Species	Crops	N fix kg/ha
Pea group	Rhizobium leguminosarum	Green pea, Lentil	62- 132
Soybean group	R.japonicum	Soybean	57- 105
Lupini Group	R. lupine orinthopus	Lupinus	70- 90
Alfafa grp.Group	R.mellilotiMedicago Trigonella	Melilotus	100- 150
Beans group	R. phaseoli	Phaseoli	80- 110
Clover group	R. trifoli	Trifolium	130
Cowpea group	R. species	Moong, Redgram, Cowpea, Groundnut	57- 105
Cicer group	R. species	Bengal gram	75- 117

1.2 Azotobacter: It is non-symbiotic nitrogen fixing bacteria recommended for non-leguminous crops like vegetables and horticultural crops. They increase crop yield by 10-20% and benefit the crop by 15-25N/ha/season.

Non-leguminous crops *Azotobacter chrococcum*

1.3 Azospirillum: This biofertilizer is involved in the fixation of atmospheric nitrogen in crops like rice, maize, sorghum,

Use of Azospirillum biofertilizer in rice cultivation

wheat and millets. It increases crop yield by 15-35%. The genus of Azospirillum is present in association with plants-roots, possess micro-aerophilic characteristic and hence, recommended for cultivation of rice[2].

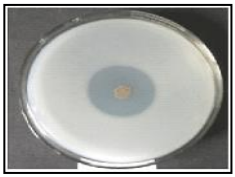
1.4 Acetobacter: The biofertilizer contains a symbiotic bacteria capable of fixing atmospheric nitrogen by living within the sugar plant. They are found in all parts of plant body[1].

Acetobacter for sugarcane

Recommendation: Rate of application is 12-15 kg/ha and the cultural practices can be adopted as follow:

- **Set Treatment:** Suspended & mixed thoroughly 5 kg bio fertilizer for one acre in 100 lit of water. Treat cane setts by dipping in this suspension before planting.
- **Soil Treatment:** Suspended 5 kg of bio fertilizer per acre in 10 liters of wate & mixed thoroughly with 80-100 kg of FYM. The mixed biofertilizer in FYM is sprinkled over cane setts in the rows at the of planting site. Immediately row should be covered[3].

2.0 Phosphate Solubilizing Bacteria (PSB)/ Potassium Solubilizing Bacteria(KSB)/Zinc Solubilizing Bacteria (ZSB):



These biofertilizers are helpful in solubilizing insoluble forms of nutrients like P, K, Zn etc. and make them available to the plants. They are responsible in increase of crop yield at least 10-25 %.

3.0 General recommendation for carrier-based biofertilizers[3]:

- Rhizobium + PSB @ 200 gm each per 10 kg of seed as seed treatment are recommended for leguminous crops.
- Azotobacter + PSB @ 200 gm each per 10 kg of seed as seed treatment are useful for non-leguminous crops like vegetables and horticultural crops.
- For transplanting rice, the recommendation is to dip the roots of seedlings for 8 to 10 hours in a solution of Azospirillum + PSB @ 5 kg each per ha.

3.1 Method of application of biofertilizers[3]:

Seed treatment | Seedling/Root dipping | Soil treatment

Seed Treatment	Seedling/ Root Treatment	Soil Treatment
200 g of N-fixing biofertilizer and 200 g of PSB are suspended in 300-400 ml of water and mixed thoroughly. Ten kg seeds are treated with this paste and dried in shade. The treated seeds have to be sown as soon as possible.	For rice crop, a bed is made in the field and filled with water. Recommended biofertilizers are mixed in this water and the roots of seedlings are dipped for 8-10 hrs.	4 kg each of the recommended biofertilizers are mixed in 200 kg of compost and kept overnight. This mixture is incorporated in the soil at the time of sowing or planting.

4.0 General recommendation and method of application for liquid biofertilizers[5]:

Seed Treatment	Seedling/Root Treatment	Soil Treatment
For small quantity of seeds (up to 5 kg quantity) the coating can be done in a plastic bag. The bag should be closed in such a way to trap the air as much as possible. The bag should be squeezed for 2 minutes or more until all the seed are uniformly wetted. Then bag is opened, inflated again and shaked gently. When each seeds gets a uniform layer of culture coating, the bag is opened and the seed is dried under the shade for 20-30 minutes. For large amount of seeds coating can be done in a bucket and inoculant can be mixed directly with hands. The important things that has to be kept in mind are that the seeds must be coated first with Rhizobium, Azotobacter, Azospirillium. When each seed gets a layer of above bacteria then PSM inoculant has to be coated as outer layer.	For application of Azospirillium/ PSB on paddy transplating/ vegetable crops this method is used. The required quantity of Azospirillum/ PSB has to be mixed with 5-10 litres of water at one corner of the field and the roots of seedlings has to be dipped for a minimum of half-an-hour before transplantation.	Use 200ml of PSB per acre. Mix PSB with 400 to 600 kg of Cow dung FYM along with ½ bag of rock phosphate under shade for overnight and maintain 50% moisture. Use the mixture as soil application in rows or during levelling of soil.

*Doses recommended when count of inoculum is $1x10^8$ cells/ml at the rate of 200ml/acre could be applied for the crop.

5.0 NPK Consortia (carrier-based & liquid):

Consortium of N_2-fixers, PSB & KSB is also available in the market. Combination of two or more microbes is prepared carrier-based or liquid to provide Nitrogen, Phosphorus and potassium to the crops.

6.0 Azolla as biofertilizers: A free floating water fern Azolla which lives in symbiotic association with a nitrogen fixing blue green algae Anabaena and is widely available in ponds & ditches and can be collected easily from local ponds. They fix atmospheric nitrogen into ammonia which is utilized by rice plant when incorporated into soil. Azolla contains from 2−5% N, 0.3−6.0% Potassium (K) (dry weight).

Use of Azolla in rice fields

Recommendation: Azolla multiplies vegetatively (i.e., it does not produce seeds). Thus, live Azolla is maintained throughout the year by growing in small ponds or water filled ditches (e.g., areas of 4−5 m^2 and depth of 0.5−1 m. You need around 250−500 g (fresh weight) inoculum for such an area). Azolla grows best at 25°C average daily temperature but dies at higher temperature. It can be utilized by rice in both wet and dry season. Azolla can be used in two ways: either as green manure incorporated before transplanting or as an intercrop incorporated after transplanting. In each case, about 500 kg (fresh weight) per ha is introduced into standing water in the rice field[4].

7.0 Blue green algae (BGA): BGA biofertilizer plays an important role in nitrogen mobilization in waterlogged paddy fields. If paddy field is provided with adequate growth of BGA then 20-30 kg of N/ha can be provided to the crop.

Recommendation: BGA is applied @ 10-15 kg per hectare of rice after 7 days of transplanting with 2.5 cm of standing water[3].

8.0 Vesicular-arbuscular mycrorrhizal (VAM) biofertilizer: They are group of fungi are intracellular obligate fungal endosymbionts which colonise roots of wide variety of agricultural, horticultural and forestry plants. Proper colonisation helps host plants with increased water and uptake of nutrient like phosphorus.

Vascular Mycorrhizal Fungi (VAM) **Maize Root With VAM Without VAM**

Types: Mycorrhizal biofertilizers are commonly divided into two types: **Ectomycorrhiza** where the hypha of fungi do not penetrate individual cells with in the plant root e.g. Basidiomycetes, some Ascomycetes, and a very few

Zygomycetes. **Endomycorrhiza** where the hypha of fungi penetrates the cell wall and invaginate the cell membrane e.g. *Scutellospora*, *Glomus*, *Acaulospora*, *Gigaspora* and *Endogone*.

8.1 Recommendation: VAM biofertilizers are available as soil root mix, as carrier base spore formulations and as liquid and can be used as seed treatment in agricultural crops and as soil treatment in nursery beds in horticulture crops, fruit trees and forestry plants[6].

8.1.1 Nursery application: 100 g inoculum is sufficient for one-meter square. The inoculants should be applied at 2-3 cm below the soil at the time of sowing. The seeds/cutting should be sown / planted above the AM inoculum.

8.1.2 For polythene bag raised seedlings (Forest trees, Coffee & Tea): About 10 g of inoculum is sufficient for each plant raised in poly bags. Mix 10 kg of inoculum with 1000 kg of potting mixture and pack the potting mixture in polythene bags before sowing.

8.1.3 For out planting: Twenty grams of VAM inoculum is required per seedling. Apply inoculum at the time of planting.

8.1.4 For existing trees: Fifty to one hundred gram of VAM inoculum is required for inoculating one tree. Apply inoculum near the root surface at the time of fertilizer application.

9.0 Precautions to take while using biofertilizers:

- ✓ Biofertilizer packets need to be stored in cool and dry place away from direct sunlight and heat because they are live product and require care in the storage**.**
- ✓ During application, right combinations of biofertilizers have to be used to get appropriate results in fields.
- ✓ As Rhizobium is crop specific, for specific leguminous crop specific rhizobium culture is always used.
- ✓ While purchasing, always ensure that each biofertilizer packet/bottle is provided with necessary information like name of the product, name of the crop for which intended, name and address of the manufacturer, date of manufacture, date of expiry, batch number and instructions for use.
- ✓ Date of expiry of the product is always checked along with specific crop and recommended method of application to be used.
- ✓ Both recommended nitrogen fixers and phosphate solubilizes are to be used to obtain the best results.

10.0 Source of procurement: Further it is also recommended that farmers should procure biofertilizers from a reliable source like State Agriculture

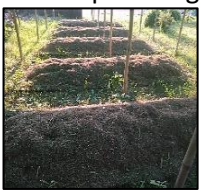
Universities, Krishi Vigyan Kendra (KVK) ICAR, or any other Govt. authorised organizations/laboratories like NFL, IFFCO etc.

II. Organic Fertilizers: These substances made up of one or more unprocessed material (s) of a biological nature (plant animal) and may include unprocessed mineral material that have been altered through microbiological decomposition process.

1.0 Vermicompost: The vermicompost preparation method depends upon the type of substrate used and bedding method followed. Similarly, based on substrates the vermicomposts are known as paddy straw, organic residues, coir pith and weeds vermicompost.

Selection of earthworm species: The red wiggler or tiger worm (*Eisenia fetida* or *Eisenia andrel*) is commonly used earthworm, but African Night crawlers (*Eudrilus eugeniae*) are another set of popular composters can be used for vermicomposting. For initial inoculation, farmers are advised to collect the earthworm cultures from reputed agencies or firms located in their region[7].

Use of *Eisenia fetida* in vermicompost



Rhino vermi bed method

Permanent Protected Vermicomposting units with drainage outlet

Crop	Quantity to apply per acre	Time to apply
Rice	1 tonne	After transplanting
Sugarcane	1 1/2 tonnes	Last ploughing
Cotton	1 tonne	Last ploughing
Chilli	1 tonne	Last ploughing
Groundnut	1/2 tonne	Last ploughing
Sunflower	1 1/2 tonnes	Last ploughing
Maize	1 tonne	Last ploughing
Turmeric	1 tonne	Last ploughing
Grape	1 tonne	June-July
Citrus, pomegranate, ber, guava	2 kg per tree	At planting time and before flowering in 1-2 year old trees
Mango, coconut	2 kg per tree 5 kg per tree 10 kg per tree 20 kg per tree	At planting time 1-5 year old trees 6-9 year old trees Trees older than 10 years
Onion, garlic, tomato, potato, bhendi, brinjal, cabbage, cauliflower	1-1 1/2 tonnes	Last ploughing
Teak, red sandal-wood, mangium	3 kg per tree	At planting time

Nutrient	Content
Organic carbon	20-25%
Nitrogen	1.5-2.0%
Phosphorus	0.5-1.5%
Potassium	0.5-1.0%
Calcium	0.4-0.8%
Magnesium	0.3-0.6%
Sulphur	100-500 ppm*
Iron	6.7-9.3 ppm
Copper	2.0-9.5 ppm
Zinc	5.7-11.5 ppm

*ppm - parts per million

Recommendations: Several types of structures are recommended for the preparation of vermicompost[8]. The nutrient value and further recommended quantity and time of application are also given in above pictures.

2.0 Farmyard manure (FYM):

FYM refers to the decomposed mixture of dung and urine of farm animals along with litter and left over material from roughages or fodder fed to the cattle. On an average well decomposed farmyard manure contains 0.5 per cent N, 0.2 per cent P_2O_5 and 0.5 per cent K_2O[9].

Method of preparation:

- ✓ During storage, nutrients are lost due to leaching and volatilization. So, it is practically impossible to avoid losses altogether, but can be reduced by following improved method of preparation of farmyard manure:
- ✓ Trenches of size 6 m to 7.5 m length, 1.5 m to 2.0 m width and 1.0 m deep are dug.
- ✓ All available litter and refuse is mixed with soil and spread in the shed so as to absorb urine.
- ✓ The next morning, urine soaked refuse along with dung is collected and placed in the trench. A section of the trench from one end should be taken up for filling with daily collection. When the section is filled up to a height of 45 cm to 60 cm above the ground level, the top of the heap is made into a dome and plastered with cow dung earth slurry.
- ✓ The process is continued and when the first trench is completely filled, second trench is prepared. The manure becomes ready for use in about four to five months after plastering.
- ✓ If urine is not collected in the bedding, it can be collected along with washings of the cattle shed in a cemented pit from which it is later added to the farmyard manure pit.

Recommendations: Vegetable crops like potato, tomato, sweet-potato, carrot, raddish, onion etc., respond well to the farmyard manure. The other responsive crops are sugarcane, rice, napier grass and orchard crops like oranges, banana, mango and plantation crop like coconut.

Generally, 10 - 20 t/ha is applied, more than 20 t/ha is applied to fodder grasses and vegetables. In such cases FYM should be applied at least 15 days in advance to avoid immobilization of nitrogen. The existing practice of leaving manure in small heaps scattered in the field for a very long period leads to loss of nutrients. These losses can be reduced by spreading the manure and incorporating by ploughing immediately after application. The entire amount of nutrients present in FYM is not

Farm Yard Manure (FYM)

available immediately. About 30 per cent of nitrogen, 60 to 70 per cent of phosphorus and 70 per cent of potassium are available to the first crop. Partially rotten farmyard manure has to be applied three to four weeks before sowing while well rotten manure can be applied immediately before sowing.

3.0 Phosphate rich organic manure (PROM):

PROM is a type of fertilizer used as an alternative to di ammonium phosphate and single super phosphate Phosphorus is required by all plants but is limited in soil, creating a problem in agriculture. The phosphorus content of PROM is around 16.5% (as soluble P_2O_5) and is directly assimilable by plants. PROM is produced by co-composting high-grade (32% P_2O_5 ± 2%) rock phosphate in very fine size (say 80% finer than 54 microns). It contains nutrients; Phosphorous, Organic carbon and Nitrogen. It acts as cost-effective alternative to DAP and makes soil soft and enriched with nutrients for long time[10].

Recommendation: This organic fertilizer is suitable for all crops and applied @ 10 to 20 t/ha in the fields. It is equally effective both in acidic as well as alkaline soils.

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