

What is INM ?

- ▶ **INM involves maintenance or adjustment of plant nutrient supply to an optimum level for sustaining the desired crop productivity.**
- ▶ **It involves proper combination of chemical fertilizers, organic manures, crop residues, nitrogen fixing crops and bio-fertilizers suitable to the system of land use and ecological, social and economic conditions.**

WHY INM ?

- ✓ Unbalanced use of N:P:K have caused deleterious long term effects on soil fertility and productivity
- ✓ In intensive cultivation, application of mere chemical fertilizers (N:P:K)
 - Not sufficient for sustaining the yields,
 - Leads to deficiency in the soil for secondary nutrients and
 - Deficiency of micro-nutrients in the soil which limit crop productivity
- ✓ Use of organic manures, green manures, crop residue and biodegradable rural and urban waste
 - Supplement the major nutrients.
 - Increase the efficiency in other nutrients supply
 - Leading to improvement in physical and biological properties of the soil

GOALS OF INM

- ❑ To maintain soil productivity
- ❑ To ensure productive and sustainable agriculture
- ❑ To reduce expenditure on cost of purchased inputs by using farm manure and crop residues etc.
- ❑ To utilize the potential benefits of green manures, leguminous crops and bio-fertilizers
- ❑ To prevent degradation of the environment
- ❑ To meet the social and economic aspirations of the farmers without harming the natural resource base of the agricultural production

PRINCIPLES OF INM

- In the soil, replenishment of chemicals removed by the crop
- Maintenance of organic matter content in the soil
- Avoidance of weeds, pests and diseases occurrence
- Control of soil acidity and toxicity
- Control of soil erosion by improving soil physical properties

OBJECTIVES OF INM

- To increase the availability of nutrients from all sources in the soil during growing season.
- To match the crop demand for nutrients, with the capacity of soil to meet this demand plus the external sources of nutrient supply.
- To optimize various soil-biota interaction.
- To minimize the loss of nutrients in the soil and also the harmful effects of chemical fertilizers on the soil health.

Components of INM

- Chemical fertilizers
- Organic manures
- Biofertilizers
- Green manures
- Crop residues
- Legumes
intercropping



Chemical fertilizers

Fertilizers are industrially manufactured chemicals containing plant nutrients. Nutrient content is higher in fertilizers than in organic manures and nutrients are released almost immediately after application such as

Fertilizers	Nutrients contents (%)		
	Nitrogen (N)	Phosphorus (P)	Potash (K)
Nitrogenous			
Urea	46		
CAN	25-28		
Ammonium Nitrate	32-35		
Phosphatic			
SSP		16	
DAP	18	46	
Potassic			
Murate of potash			60.0
Potassium sulphate			48.0-52.0

Use of Organic Manures In Horticultural crops

Farm Yard Manure (FYM):

- This is the traditional manure and is mostly readily available to the farmers.
- Farm yard manure is a decomposed mixture of Cattle dung and urine with straw and litter used as bedding material and residues from the fodder fed to the cattle.
- Well rotten farm yard manure contains **0.5% N**, **0.25% P_2O_5** and **0.5% K_2O** .



Vermicompost

- ✓ Compost that is prepared with the help of earthworms is called vermicompost.
- ✓ The earthworms may be of local species or more vigorous exotic ones.
- ✓ The casts of the earthworm have several enzymes and are rich in plants nutrients, beneficial bacteria and mycorrhizae.
- ✓ On an average, vermicompost contains **3% N, 1% P_2O_5 and 1.5% K_2O** .
- ✓ Presence of earthworms help in aerating the soil.



GREEN MANURES

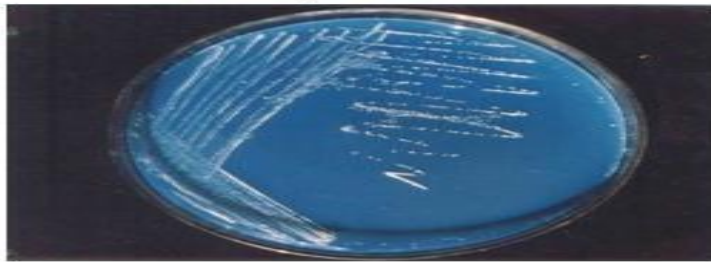
- Green manuring is growing in the field plants usually belonging to leguminous family and incorporating into the soil after sufficient growth.
- The most important green manure crops are sunnhemp, dhaincha, clusterbeans and *Sesbania rostrata*.



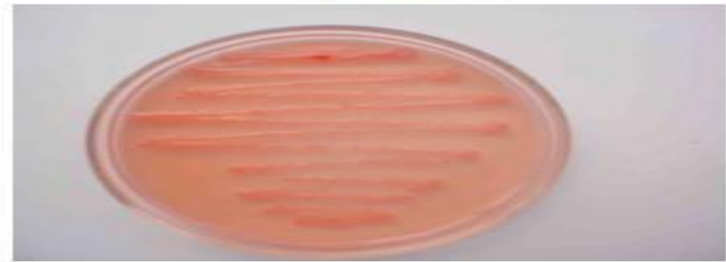
Bio-fertilizer ?

“Biofertilizers are the carrier-based inoculants containing cells of efficient strains of specific microorganisms used by the farmers for enhancing productivity of the soil.”

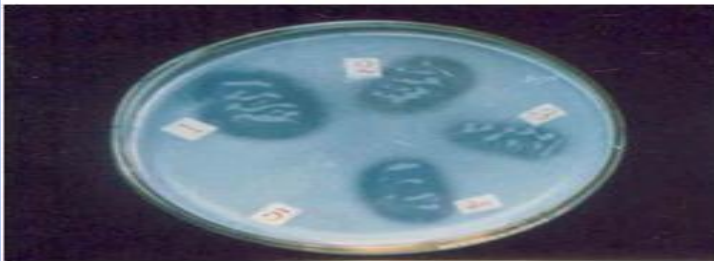
Azospirillum



Rhizobium



Phosphobacteria



Azotobacter



Why to apply bio-fertilizers ?

- ↗ Fix atmospheric nitrogen
- ↗ Dissolve soil phosphorus
- ↗ Stimulate plant growth through synthesis of growth promoting substances.

CLASSIFICATION OF BIOFERTILIZERS

N₂ fixing Biofertilizers

1.	Free-living	<i>Azotobacter, Beijerinckia, Clostridium, Klebsiella, Anabaena, Nostoc,</i>
2	Symbiotic	<i>Rhizobium, Frankia, Anabaena azollae</i>
3	Associative Symbiotic	<i>Azospirillum</i>

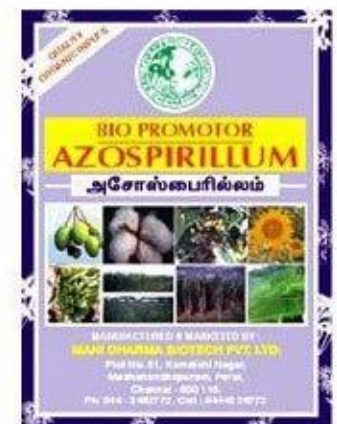
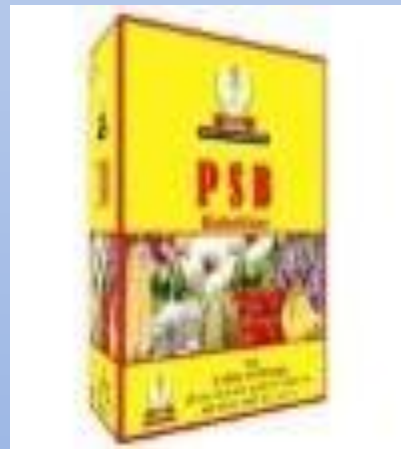
P Solubilizing Biofertilizers

1.	Bacteria	<i>Bacillus megaterium var. phosphaticum, Bacillus subtilis Bacillus circulans, Pseudomonas striata</i>
2	Fungi	<i>Penicillium sp, Aspergillus awamori</i>

S. N.	Group	Example
P Mobilizing Biofertilizers		
1	Arbuscular mycorrhiza	<i>Glomus sp., Gigaspora sp., Acaulospora sp., Scutellospora sp. & Sclerocystis sp.</i>
2	Ectomycorrhiza	<i>Laccaria sp., Pisolithus sp., Boletus sp., Amanita sp.</i>
3	Ericoid mycorrhizae	<i>Pezizella ericae</i>
4	Orchid mycorrhiza	<i>Rhizoctonia solani</i>
Biofertilizers for Micro nutrients		
1.	Silicate and Zinc solubilizers	<i>Bacillus sp.</i>
Plant Growth Promoting Rhizobacteria		
1.	Pseudomonas	<i>Pseudomonas fluorescens</i>

Bio-fertilizers used in Horticultural crops

Sl. No.	Biofertilizers
1.	<i>Azotobacter</i>
2.	<i>Azospirillum</i>
3.	Phosphate solubilising bacteria (PSB)
4.	<i>Rhizobium</i> / <i>Bradyrhizobium</i>
5.	<i>Pseudomonas striata</i>
6.	<i>Trichoderma</i>
7.	Vesicular Arbuscular Mycorrhizae (VAM)



Rhizobium:

Rhizobium is a soil habitat bacterium, which can able to colonize the legume roots and fixes the atmospheric nitrogen symbiotically.



Azospirillum sp.

- *Azospirillum* an associative micro-aerophilic nitrogen fixer commonly found in association with the roots of higher plants is of interest.
- Low energy requirement, high nitrogen fixation capacity, can fix 20-40 kg N/ha and tolerance to high soil temperature (30-40 °C) are responsible for its suitability under tropical conditions.
- The most important *Azospirillum* spp. is *A. brasilense* which has wide range of tolerance against abiotic stresses.



Azotobactor sp.

- A free living heterotrophic nitrogen fixing bacteria encounter in neutral to alkaline soil conditions.
- *A. chroococcum* and *A. vinilandii* are deemed to be the most commonly occurring species. fixes



Phosphate solubilising bacteria (Phosphobacteria):

They secrete organic acids and lower the pH in their vicinity to bring about dissolution of bound phosphates in soil.

Phosphate solubilising microorganisms are recommended for all crops and can solubilize 20-30%



VAM fungi (vesicular-arbuscular mycorrhizae)

- Mycorrhizal associations produced by fungi are known as arbuscular mycorrhizas, or vesicular-arbuscular mycorrhizas.
- the major genus is *Glomus*, considered to be the most abundant of all soil fungi.
- It is an obligate symbiotic fungus and is not very host specific.



Benefits / Advantages of Bio-fertilizers

- ↗ Increase crop yield by 20-30%.
- ↗ Replace chemical nitrogen and phosphorus by 25%.
- ↗ Stimulate plant growth.
- ↗ Activate the soil biologically.
- ↗ Restore natural soil fertility.
- ↗ Provide protection against drought and some soil borne diseases.
- ↗ Cost effective, i.e. reduces the costs toward fertilizers use, especially regarding nitrogen and phosphorus
- ↗ Supplement to fertilizers.
- ↗ Eco-friendly (Friendly with nature).

Inter cropping

- Intercropping involves growing a smother crop between rows of the main crop.
- The inclusion of intercrop crops such as legume



General nutritional recommendations for important fruit crops

Crops	Nutrient recommendation (g/plant)		
Banana	300	90	200
Mango(Adult)	750	160	750
Papaya	200	200	250
Sapota	1000	500	500
Guava (Adult)	200	320	250

General nutritional recommendations for important vegetable crops

Crops		Nutrient recommendation (kg/ha.)	
Tomato	150	75	75
Hybrid Tomato	150	90	90
Brinjal	100	50	50
Hybrid Brinjal	150	75	75
Onion	80	50	80
Garlic	100	50	50
Okra	60	30	0
Elephant Foot Yam	80	60	100
Greater Yam	80	60	80
Turmeric	120	90	90
Ginger	120	90	90
Fenugreek	20	60	30

Advantages of Integrated Nutrient Management

- Improvement in the soil physical properties such as granulation, porosity, water holding and drainage capacity, aeration etc.
- Improvement in the organic matter content in the soil
- Balanced nutrition to the crops, better nutritional uptake and hence better plant growth and yield
- Improvement in the produce's quality appearance, taste and nutritional richness.
- Maintenance of soil nutrients reserve

- Fruitful utilization of farm wastes
- Reduced use of chemical fertilizers reduces pollution of ground water and environment
- Some organic sources are cheaply available hence help reduce the production cost
- Enrichment of soil with beneficial soil micro organisms
- Better tolerance to biotic and abiotic stresses
- Residual effect remains beneficial to other succeeding crops

APPLICATION OF FERTILIZERS

i) Basal application (Broadcasting at sowing or planting)

- Applying and incorporating of fertilizers into the soil before or at sowing.
- Uniformly distribute the fertilizer over the entire field and to mix it with soil.



ii) Top dressing.

- The objective is to supply nitrogen in readily available form to growing plants.
- Generally given after the plant is properly established and root is well developed.



Placement method

- It refers to the placement of fertilizers in soil at a specific place with or without reference to the position of the seed

Placement of fertilizers is normally recommended when:

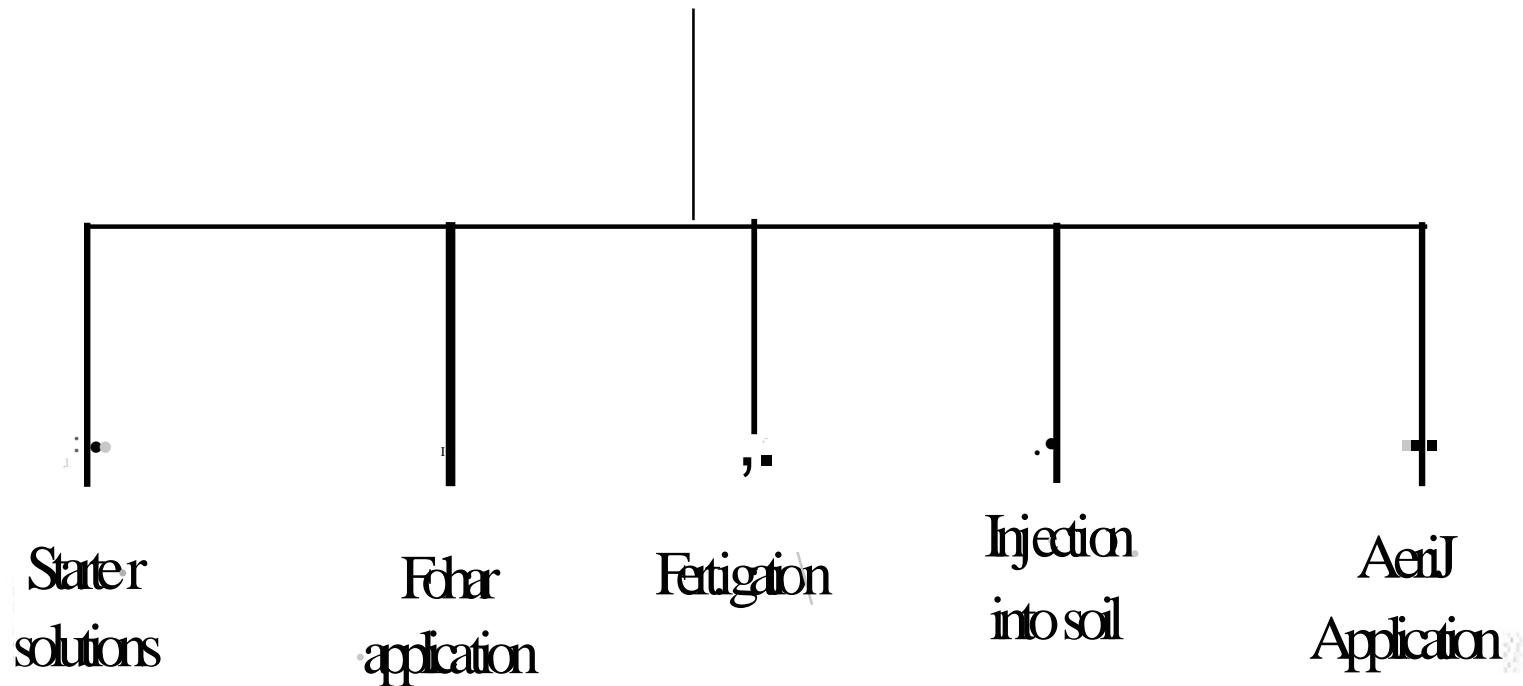
- The quantity of fertilizers to apply is small
- Development of the root system is poor
- Soil have a low level of fertility
- To apply phosphatic and potassic fertilizer

Advantages

- When the fertilizer is placed, there is minimum contact between the soil and the fertilizer, and thus fixation of nutrients is greatly reduced.
- The weeds all over the field can not make use of the fertilizers.
- Residual response of fertilizers is usually higher.
- Utilization of fertilizers by the plants is higher.
- Loss of nitrogen by leaching is reduced. Being immobile, phosphates are better utilized when placed.

METHODS OF LIQUID FERTILIZER APPLICATION

2. Application of liquid fertilizers



Starter solution

It refers to the application of solution of N, P_2O_5 and K_2O in the ratio of 1:2:1 and 1:1:2 to young plants at the time of transplanting, particularly for vegetables.

Advantage

Starter solution helps in rapid establishment and quick growth of seedlings.

Disadvantages

- (i) Extra labour is required, and
- (ii) Fixation of phosphate is higher.



Foliar application

- It refers to the spraying of fertilizer solutions containing one or more nutrients on the foliage of growing plants.
- Several nutrient elements are readily absorbed by leaves when they are dissolved in water and sprayed on them.
- The concentration of the spray solution has to be controlled, otherwise serious damage may result due to scorching of the leaves.
- Foliar application is effective for the application of minor nutrients like iron, copper, boron, zinc and manganese. Sometimes insecticides are also applied along with fertilizers.

Fertigation

- It refers to the application of water soluble fertilizers through irrigation water.
- The nutrients are thus carried into the soil in solution.
- Generally nitrogenous fertilizers are applied through irrigation water.



b) Foliar application

