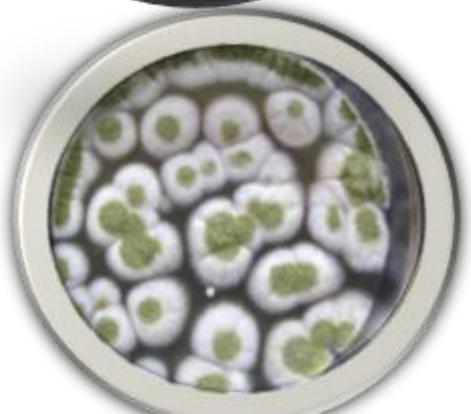
University of Agricultural Sciences, Dharwad
Department of Agricultural Microbiology

Microbial resources in organic and natural farming



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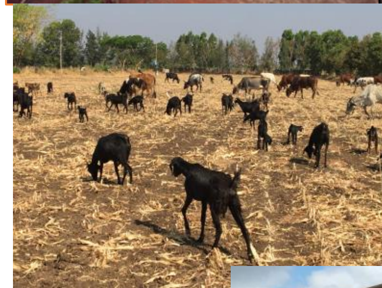
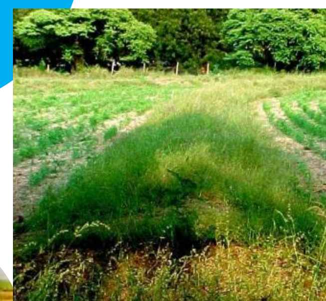
Institute of Organic Farming, UAS Dharwad

Bioresource centre



Fixed plot blocks



Sales point for inputs and produce

UNIVERSITY OF AGRICULTURAL SCIENCES, DHARWAD

Institute of Organic Farming (IOF)

About the Institute

Institute of Organic Farming (IOF) is the first of its kind in the country established during 2006 under RKVY project.

Objectives:

- **Development of location specific organic farming practices for important crops and cropping sequences.**
- **Research studies on productivity, profitability, sustainability, quality and input use efficiency of conventional and organic production systems across different agro-climatic regions.**
- **Survey and documentation of existing knowledge on organic farming practices.**
- **Selection and development of crop varieties suitable for organic production and their seed production.**
- **Development of infrastructure facilities to undertake quality analysis of organic inputs and residual analysis of organic products.**
- **Identification efficient strains, isolation, maintenance and mass multiplication of bio-inputs**

ACTIVITIES

1. Bio-resource centre of 40 acres – a certified organic farm comprising animal husbandry, vermicompost, vermiwash units, organic seed production, agri silvi and silvi horti systems. A learning centre
2. Fixed plots maintained since 2004, under organic, integrated and conventional production systems to evaluate crops and cropping systems.
3. Well established referral laboratory facilities for

- Studying the soil physical, chemical and biological properties.
- Quality assessment of organic inputs, biofertilizers and bio-pesticides.
- Culture development, maintenance and supply to line departments and private agencies for mass production

4. Mass production units for biofertilizer and biopesticides.





ACCOMPLISHMENTS

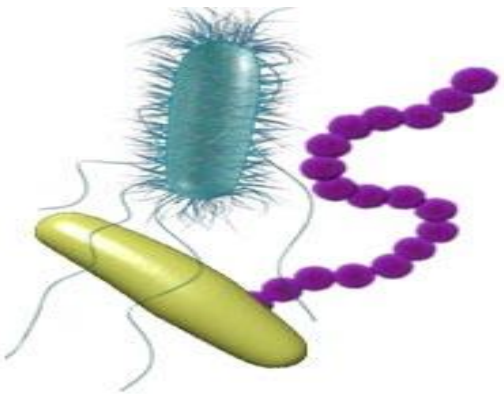
1. Over 17 years of development, research and extension in Organic agriculture.
2. A model, certified bio-resource farm with cropping systems, input production crop and animal husbandry.
3. Organic, integrated and conventional blocks maintained since 2003.
4. Operated and successfully completed twenty six research projected with outcomes for adoption and policy making.
5. More than 300 trainings with Five national contributing to Human resource development and provided impetus to initial organic movement covering over 5000 farmers, 250 officials, 200 scientists and over 100 officers, spreading and sharing knowledge with hundreds of policy makers also visitors from 10 countries overseas.
6. Developed 17 Organic packages for 14 crops and 20 organic production technologies.
7. Bio-input production including enriched organic manures (200 tons per annum), biofertilizers and biopesticides and supply to farmers (around 100 tons per annum).
8. Laboratory infrastructure for organic research, quality analysis and mass production
9. Recipient of the best AI-NPOF centre for the year 2021-22.
10. Publication of research accomplishments, organic package, farmers hand book, DVDs for dissemination of technology and knowledge thus contributing to organic movement.

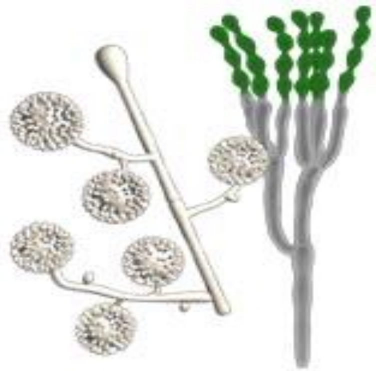
Different Components of Bio-resource farm in IOF, UAS, Dharwad.

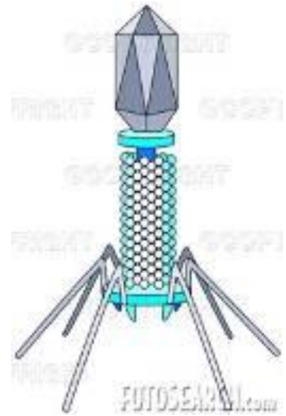
Sl. No	Component	Area
1	Organic input production unit	0.5 acre
2	Livestock unit	0.5 acre
3	Horticulture unit	6.0 acre
4	Fodder production unit	2.0 acre
5	Seed	30.0 acre

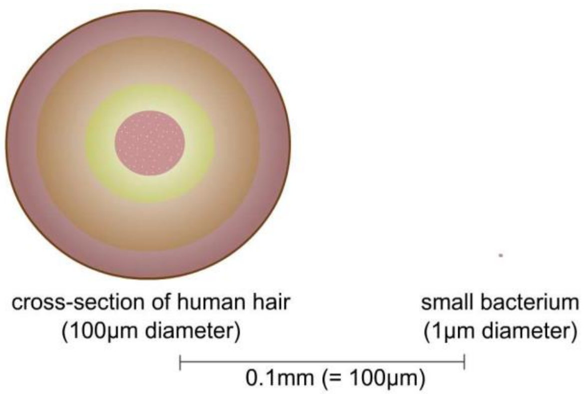
Microorganisms?

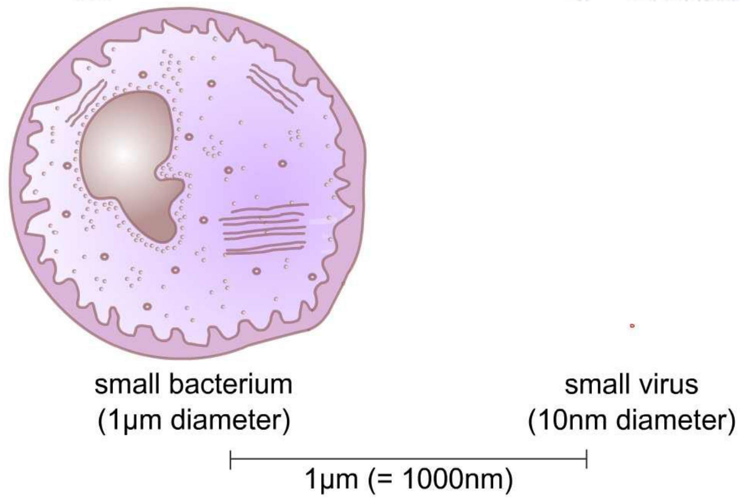
- **Very small <100 µm**
- **Single cells, some multicellular no tissue specialization**
- **Capable of independent existence**

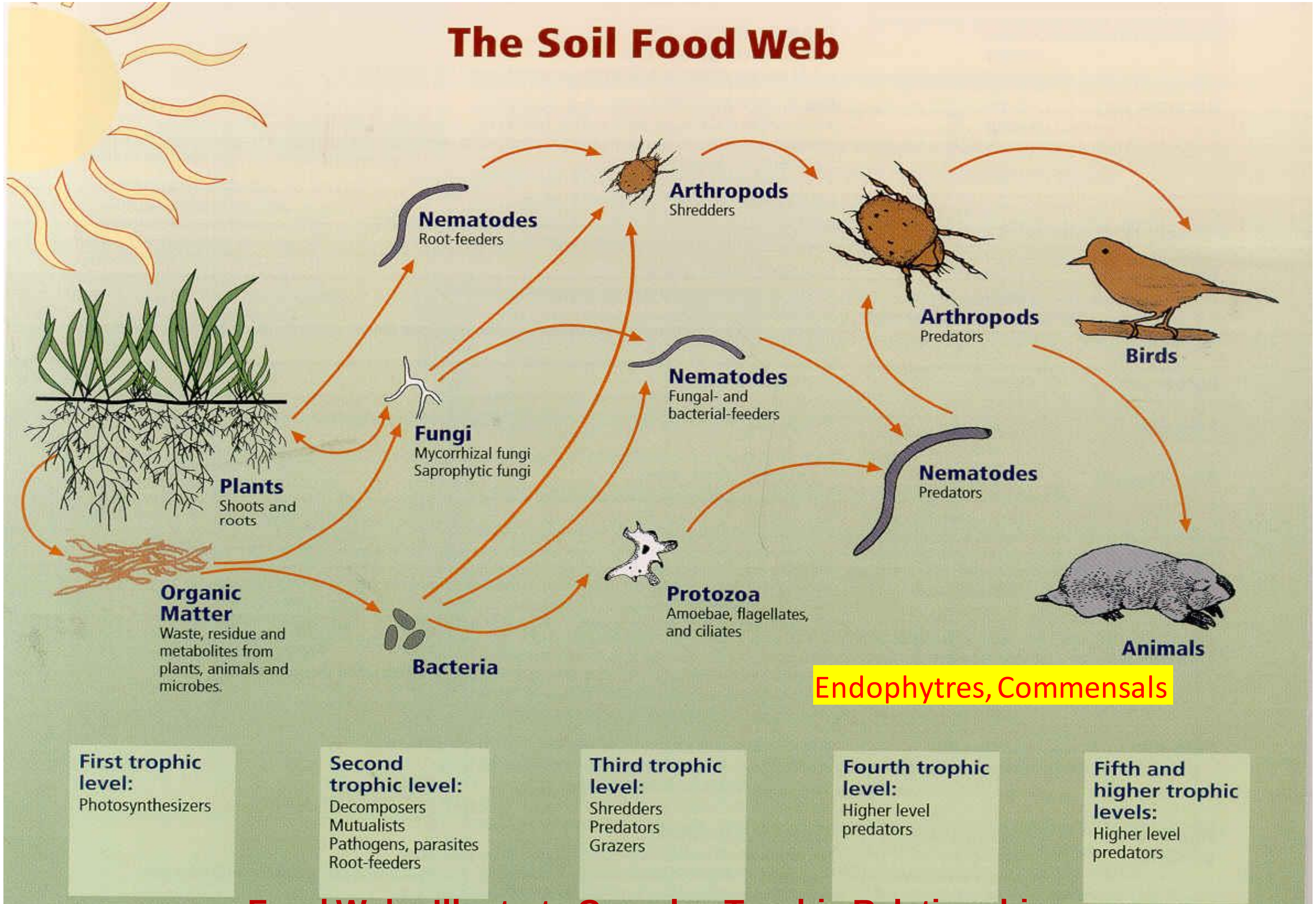












Endophytres, Commensals

Food Webs Illustrate Complex Trophic Relationships

Why Microorganisms?

Microbial diversity is the most resourceful, unexplored resource: Less than one per cent of them are known

- **Microbes have demonstrated a great deal of versatility, adaptability, survivability, propagation and ability to inhabit a wide variety of environment**


Sahara desert


Yellowstone National park


Lake Magadi, Tansania


Yellowstone National park

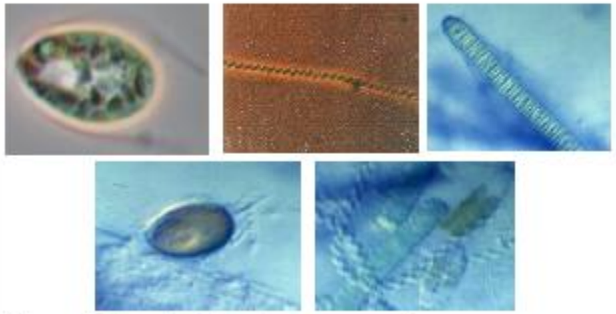
Smoke bellow


Anaerobic digester

- Likely to provide innovative applications useful to man, representing by far the richest repertoire of molecular and chemical diversity in nature.
- Health applications: antimicrobial agents and enzymes, enzyme inhibitors, antihelminthics, antitumor agents, insecticides, vitamins, immunosuppressant and immunomodulators
- Food preservation, management of pests and pathogens, bioleaching of metals, increasing soil fertility, generating biofuels, monitoring pollutants, ridding coal mines from methane, cleaning up of oil spills, waste water treatment, assaying of chemicals and serving as tools for medical research, bioremediation etc.,

Applications

Photosynthetic bacteria



Use sunlight and soil heat as a source of energy. Synthesise useful substances (eg. amino acids, nucleic acids and sugars) from secretions of roots, organic matter and / or harmful gases (eg. hydrogen sulphide)

Succession !!!

Carbon sequestration or degradation?

Lactobacillus bacteria

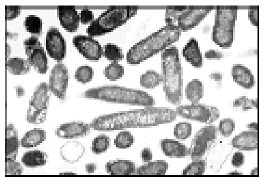
Produce lactic acids from the sugars and other carbohydrates developed by photosynthetic bacteria and yeast. Strong sterilising compound and suppresses harmful micro-organisms and enhances the decomposition of organic matter.

FOOD!!!

Restoration!!!

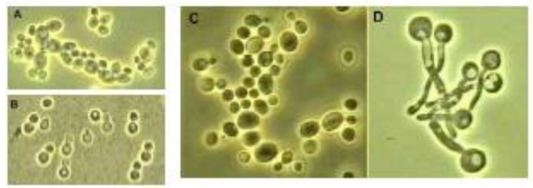
Bacteria and antibiotics

Pseudomonas bacteria



The cell wall is the target for antibiotics, as well as for carbohydrates that our immune system uses to detect infection.
A major threat to humankind is the antibiotic-resistant strains of bacteria that have been selected by the overuse of antibiotics.

Yeast organisms

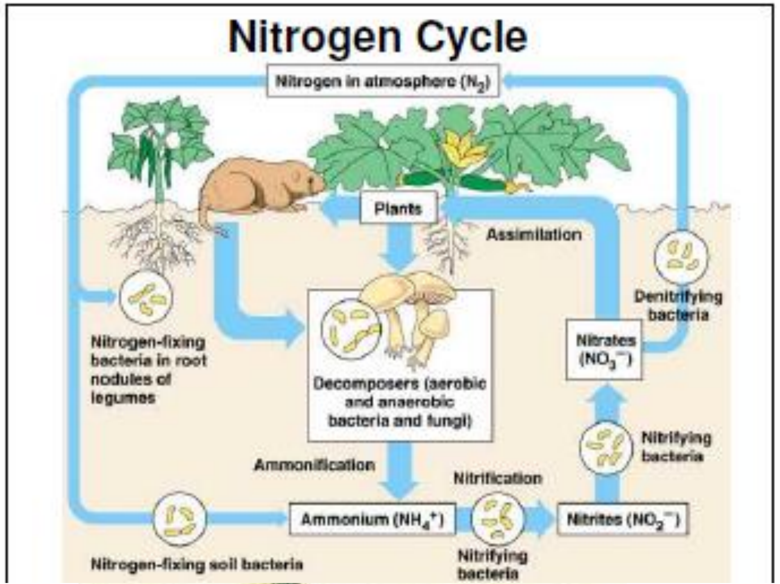


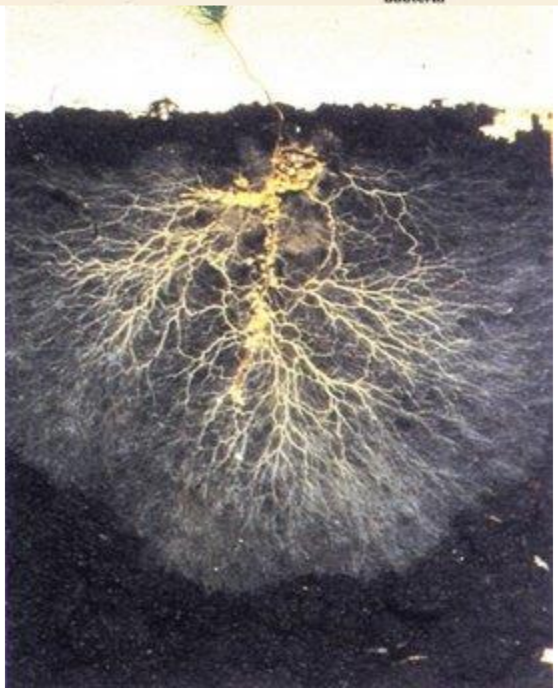
Synthesise anti-microbial and other useful substances required for plant growth from amino acids and sugars secreted by photosynthetic bacteria, organic matter and plant roots. Produce bio-active substances such as hormones and enzymes that promote active cell and root division.

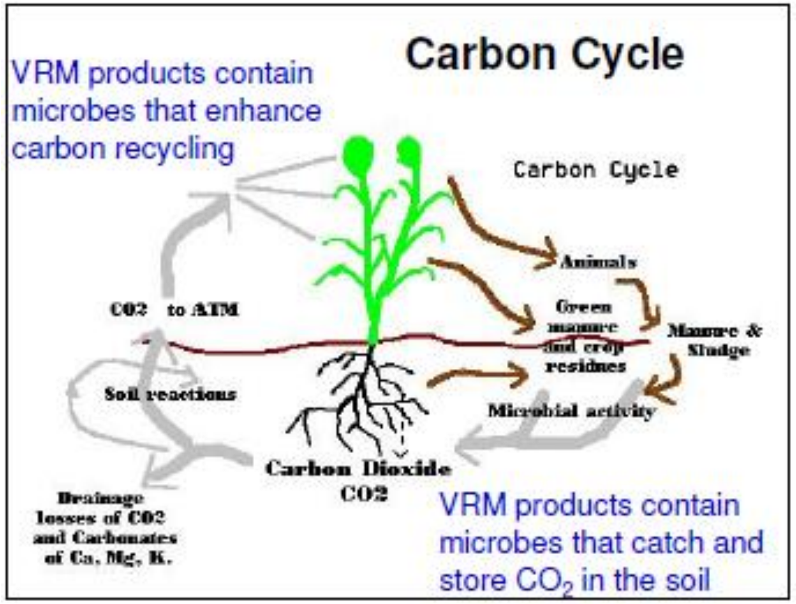
Fermetation !!!

Life saving drugs !!!

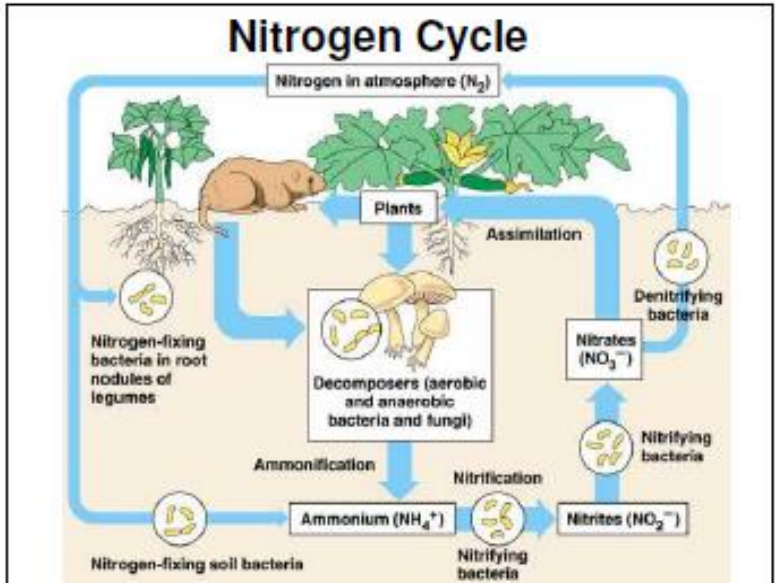
Applications





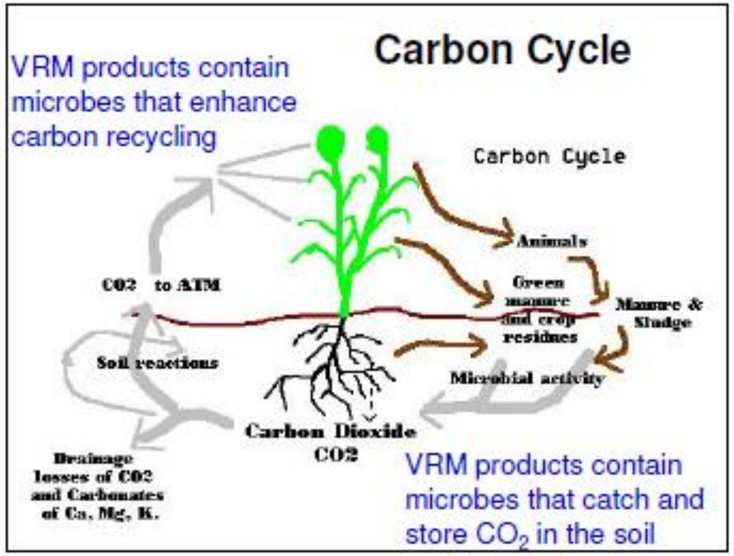


Applications



Annually
175×10^6 metric tonnes
140 x 10 6 metric tonnes due to Legume Rhizobium symbiosis

MOs in all trophic levels



Microbes as primary producers, consumers, heterotrophs, chemotrophs

Only with microbes!!!

- Anaerobic life
- Anaerobic photosynthesis
- An-oxygenic photosynthesis
- Hostile environment
- Nitrogen fixation
- Position in food chain

Occurrence and distribution of microorganisms in soil

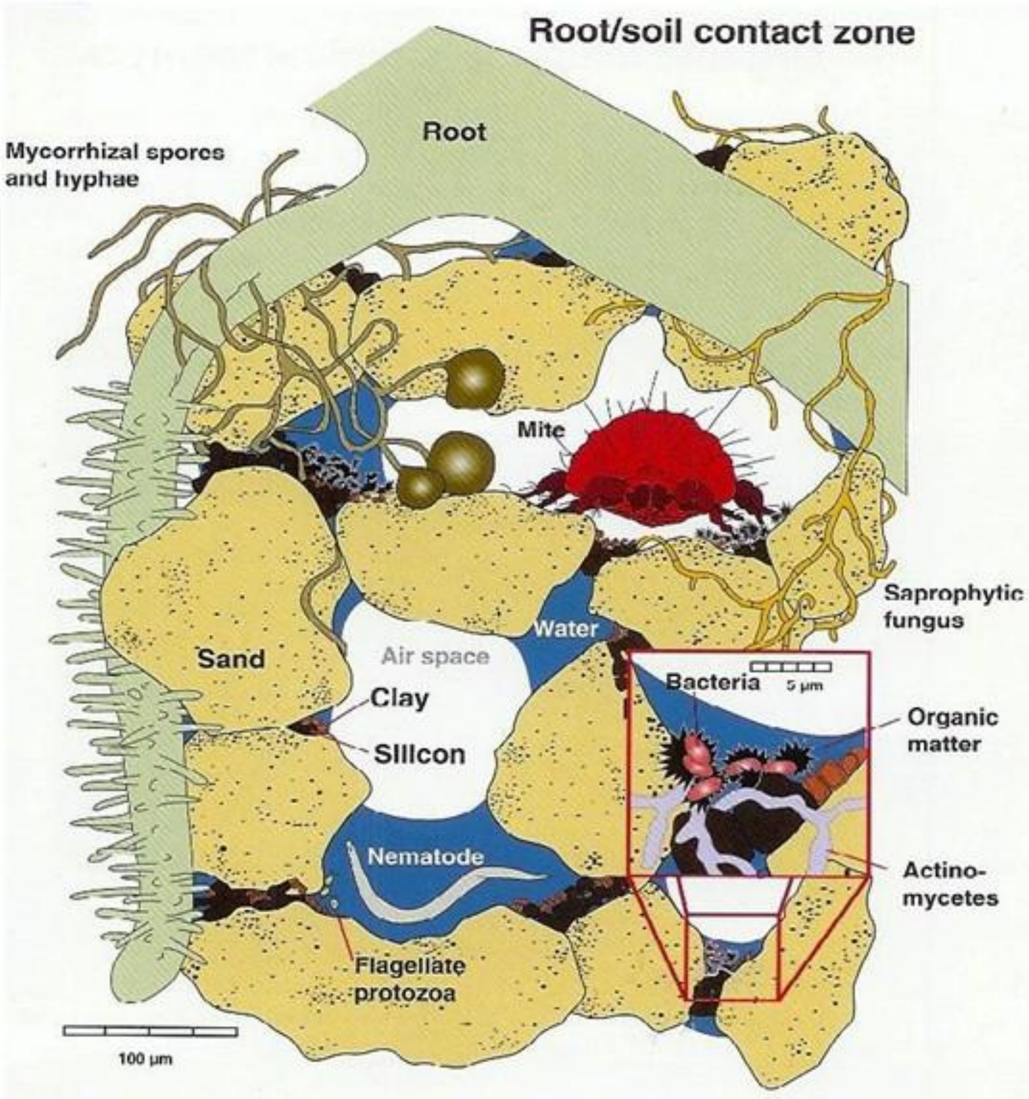
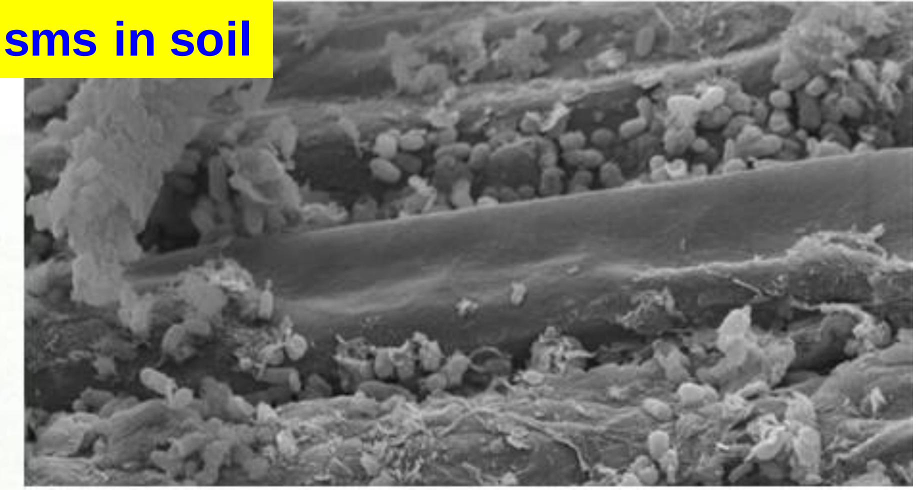


Figure 4. Microbial life in the root/soil contact zone. Source: Principles and Applications of Soil Microbiology (2nd edition), Prentice Hall, 2004.



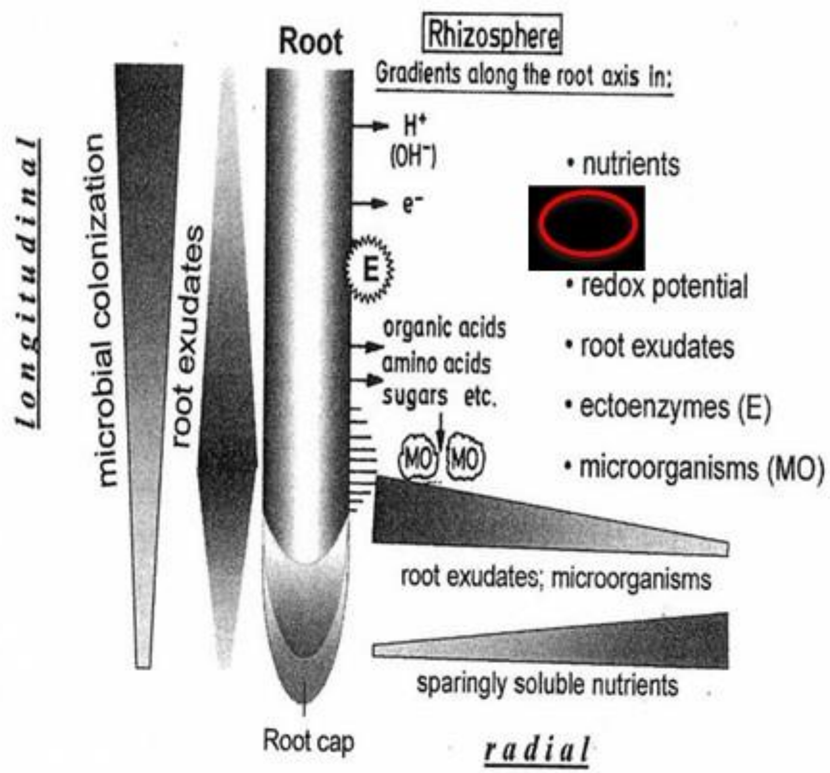


Figure 1 Gradients in the rhizosphere.

Limiting factors: Air, Carbon, Water and Light for photosynthetic microbes..

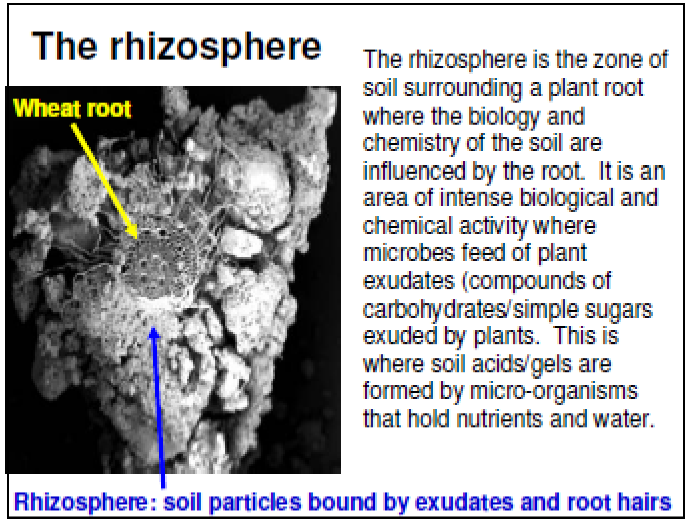
SPECIFIC ECOSYSTEM SERVICES FROM MICROBIAL DIVERSITY

- Decomposing organic matter.
- Cycling and immobilizing inorganic nutrients.
- Filtering and bioremediating soil contaminants.
- Suppressing and causing plant diseases.
- Producing and releasing greenhouse gasses.
- Improving soil porosity, aggregation and water infiltration.

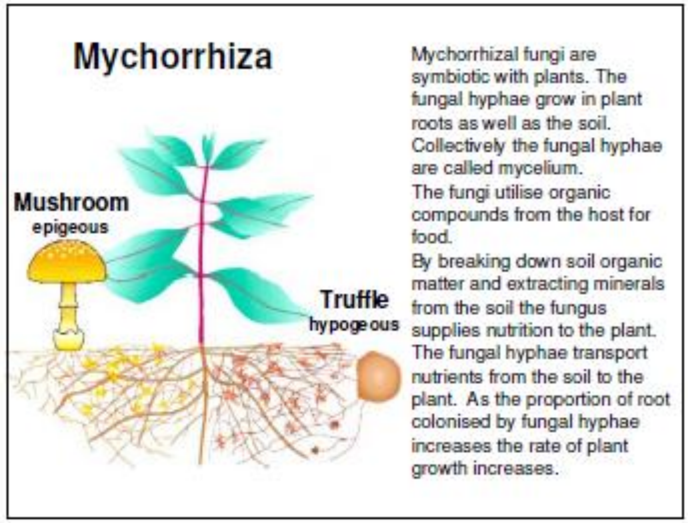
Good structure

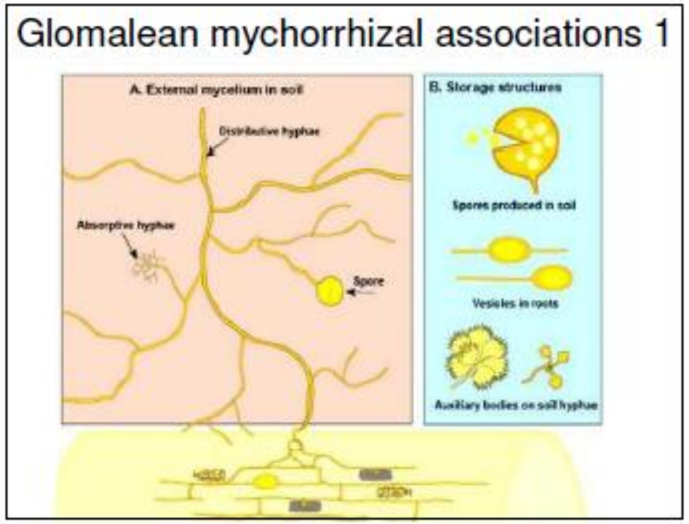
Poor structure

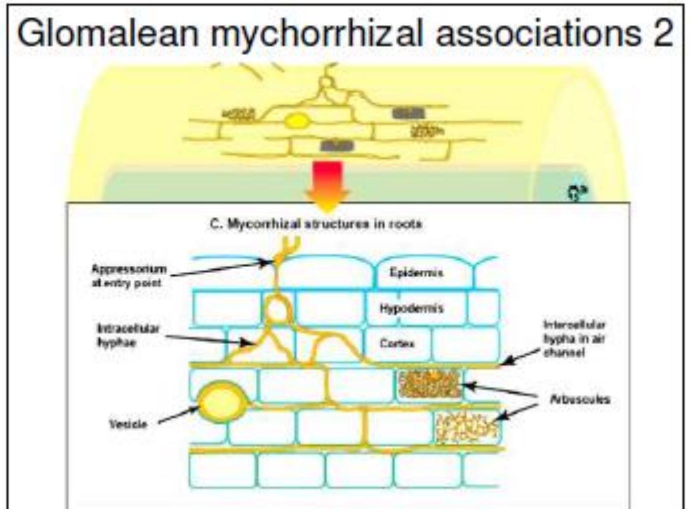
Applications



OMD
Prevent erosion
Soil aggregation
Mobilization





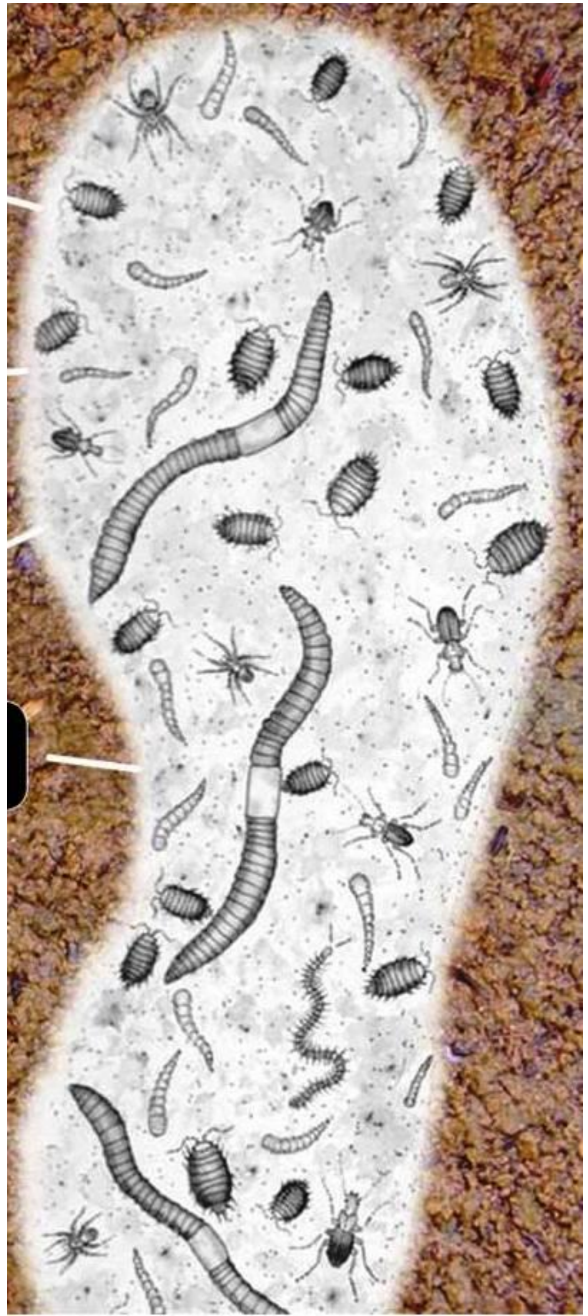


A FOOT PRINT OF SOIL

Organisms of soil with representative size, numbers and estimates of their biomass in soil.

Microbial group	Representative organism	Size (µm)	Numbers g^{-1} of soil	Biomass (kg wet mass ha^{-1} soil)
Viruses	Tobacco mosaic	0.02 x 0.3	$10^{10} – 10^{11}$	
Bacteria	*Pseudomonas*	0.5 x 1.5	$10^{8} – 10^{9}$	300 - 3,000
Actinomycetes	*Streptomyces*	0.5 x2.0 $	$10^{7} – 10^{8}$	300 – 3,000
Fungi	*Mucor*	8.0 $	$10^{5} – 10^{6}$	500 – 5,000

THE NUMBER OF ORGANISMS IN A SPOONFUL OF SOIL IS MORE THAN THE WORLD'S HUMAN POPULATION

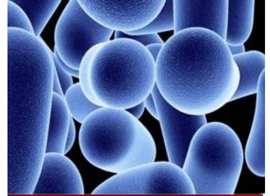
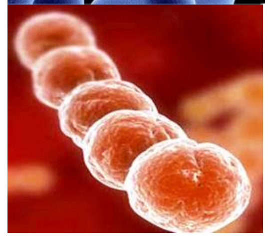


Role of microorganisms in sustaining life in BIOSPHERE

Soil Formation - aeration, erosion prevention, mix organic matter, aggregate particles, store C, long term soil stability

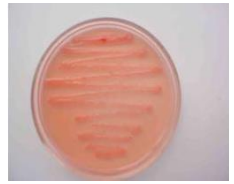
Without soil biota - Lack of stable soil structure would result in lower plant nutrient availability and lower the resistance to soil erosion - Decline in ecosystem service

Function of specific group of Soil Microorganisms

Bacteria:

- Maintaining soil fertility to supporting plant growth
- Antibiotics and other potential medicines
- Bacteria are able to use a broad spectrum of biochemical processes to produce energy.
- Fix nitrogen from the atmosphere in a form (the ammonium ion, NH_4^+)
- Free-living microbes strongly regulate plant productivity through the mineralisation of nutrients that sustain plant productivity
- Conservative estimates suggest that 20,000 plant species are completely dependent on microbial symbionts for growth and survival - this points to the importance of soil microbes as regulators of plant species richness on earth.




Fungi

- Some fungi can be pathogenic
- Mutually beneficial (symbiotic) relationships with them.
- Over 90% of all plant species engage in and depend on mycorrhizal relationships with Specialized fungi hunt for other soil organisms such as nematodes/protozoans by means of traps such as rings, snares or adhesive structures.






Function of Soil Microorganisms

Algae:

By excreting extracellular high-molecular weight substances, topsoil algae contribute to the stabilisation of soil particles and therefore to soil structure. This in turn protects soil surface from erosion - literally holding the soil in. his important service protects the top soil enabling it to grow crops, thus being a bio-indicator for soil quality.

Viruses

Viruses are the most numerous and least understood of all biological entities in soil. They are capable of infecting bacteria, fungi, insects, plants and animals. It is envisaged viruses may one day find a wide application for the biocontrol of insects, weeds, fungal infections and other noxious organisms. Survival of viruses in soil depends on the kind of virus, the presence of susceptible host and the appropriate environmental conditions

Agriculture Situation in India

Status of fertilizer use in India

Indian Journal of Fertilisers **19** (9) : 830-831, September, 2023

Fertilizer Scenario during 2022-23

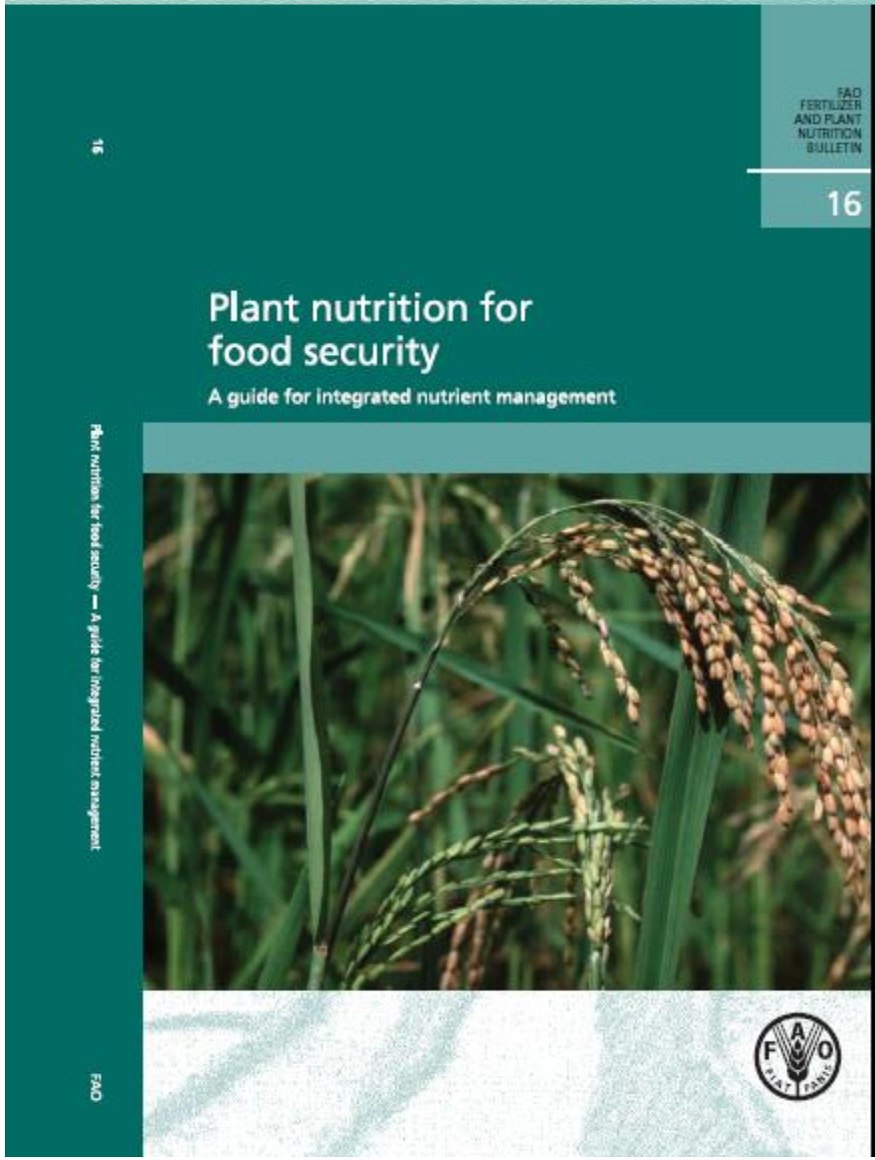
Frank Notes

Arvind Chaudhary

1.2 million MT to the urea production of 28.5 million MT thereby resulting a growth of 13.6% in urea production in 2022-23 over 2021-22. Production of phosphate (P_2O_5) showed healthy increase by 6.3% during the year. Production of urea could have been more but some plants suffered due to equipment and maintenance related problems and constraint in availability of working capital. Production of P_2O_5 could also have been more but some plants suffered due to lack of availability of sufficient quantity of imported raw materials/intermediates and high cost.

Natural gas is essential input both as feed and fuel for production of nitrogen containing fertilizers. The

Consumption of total fertilizer nutrients, estimated at 29.84 million MT during 2022-23, registered a marginal growth of 0.2% over 2021-22. Consumption of N and P_2O_5 registered increase of 4% and 1.2%, respectively, over 2021-22. However, consumption of K_2O witnessed a sharp decline of 32.2%. India is import dependent to a great extent to meet its fertilizer demand either through import of finished products or raw materials. International market is quite volatile and prices depend on demand supply positions and geopolitical situations. This happened in 2022-23 also when the industry procured the materials at exorbitantly



BIOFERTILIZERS (MICROBIAL INOCULANTS)

Definition, classification and general aspects

Definition

Biofertilizer is a broad term used for products containing living or dormant micro-organisms such as bacteria, fungi, actinomycetes and algae alone or in combination, which on application help in fixing atmospheric N or solubilize/ mobilize soil nutrients in addition to secreting growth-promoting substances. They are also known as bioinoculants or microbial cultures. Strictly speaking, although widely used, the term biofertilizer is a misnomer. Unlike fertilizers, these are not used to provide nutrients present in them, except in the case of *Azolla* used as green manure.

Classification

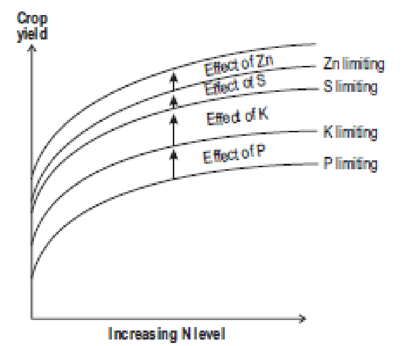
Biofertilizers can be grouped into four categories:

- N-fixing biofertilizers: These include the bacteria *Rhizobium*, *Azotobacter*, *Azospirillum*, *Clostridium* and *Acetobacter* among others; BGA or cyanobacteria and the fern *Azolla* (which works in symbiosis with BGA).
- P-solubilizing/mobilizing biofertilizers: These include phosphate-solubilizing bacteria (PSB) and phosphate-solubilizing micro-organisms (PSMs), e.g. *Bacillus*, *Pseudomonas* and *Aspergillus*. Mycorrhizae are nutrient-mobilizing fungi, also known as vesicular-arbuscular mycorrhizae or VA-mycorrhizae or VAM.
- Composting accelerators: (i) cellulolytic (*Trichoderma*); and (ii) lignolytic (*Humicola*).
- Plant-growth-promoting rhizobacteria (PGPR): Species of *Pseudomonas*. These do not provide plant nutrients but they enhance plant growth and performance.

avoided.

Balanced crop nutrition is not the same as balanced fertilization. The latter should make the former possible. For example, only soils equally poor in available N, P and K should be fertilized with these three nutrients in balanced amounts. This can best be done using soil-test and crop removal data. Where a soil is rich in one nutrient, fertilization should be directed to the deficient nutrients in order to make balanced crop nutrition possible. Thus, the goal is not balanced fertilization as such but balanced crop nutrition through balanced nutrient application in order to supplement those nutrients that are deficient in the soil.

FIGURE 28
Yield response to balanced plant nutrition



Source: FAO, 1998 (modified to include S and Zn).

CHALLENGES

These trends pose a series of challenges to food and agriculture.

High-input, resource-intensive farming systems, which have caused massive deforestation, water scarcities, soil depletion and high levels of greenhouse gas emissions, cannot deliver sustainable food and agricultural production. Needed are innovative systems that protect and enhance the natural resource base, while increasing productivity. Needed is a transformative process towards 'holistic' approaches, such as agroecology, agro-forestry, climate-smart agriculture and conservation agriculture, which also build upon indigenous and traditional knowledge. Technological improvements, along with drastic cuts in economy-wide and agricultural fossil fuel use, would help address climate change and the intensification of natural hazards, which affect all ecosystems and every aspect of human life. Greater international collaboration is needed to prevent emerging transboundary agriculture and food system threats, such as pests and diseases.

Hunger and extreme poverty have been reduced globally since the 1990s.

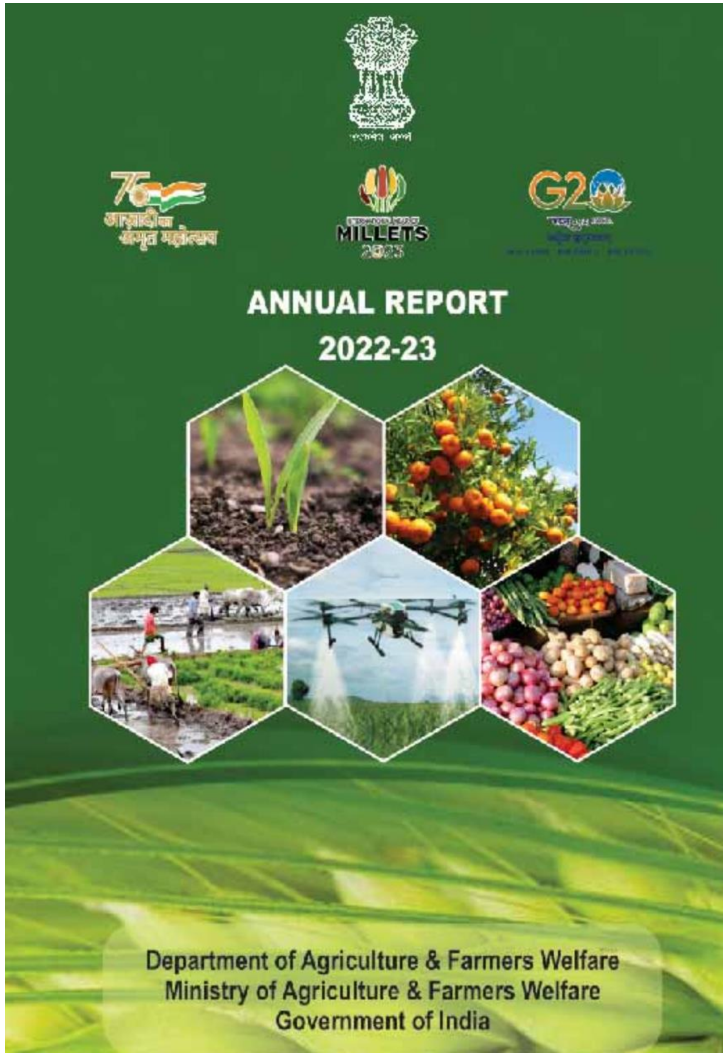
Yet, around 700 million people, most of them living in rural areas, are still extremely poor today. In addition, despite undeniable progress in reducing rates of undernourishment and improving levels of nutrition and health, almost 800 million people are chronically hungry and 2 billion suffer micronutrient deficiencies. Under a 'business-as-usual' scenario, without additional efforts to promote pro-poor development, some 653 million people would still be undernourished in 2030. Even where poverty has been reduced, pervasive inequalities remain, hindering poverty eradication.

Critical parts of food systems are becoming more capital-intensive, vertically integrated and concentrated in fewer hands.

This is happening from input provisioning to food distribution. Small-scale producers and landless households are the first to lose out and increasingly seek employment opportunities outside of agriculture. This is driving increased migratory flows, especially of male members of rural households, which is leading, in turn, to the 'feminization' of farming in many parts of the world.

Conflicts, crises and natural disasters are increasing in number and intensity.

They reduce food availability, disrupt access to food and health care, and undermine social protection systems, pushing many affected people back into poverty and hunger, fuelling distress migration and increasing the need for humanitarian aid. Violent conflict also frequently characterizes protracted crises. On average, the proportion of undernourished people living in low-income countries with a protracted crisis is between 2.5 and 3 times higher than in other low-income countries.



7.28 Soil Health Management (SHM): Ministry of Agriculture, Cooperation and Farmers Welfare, Department of Agriculture and Cooperation & Farmers Welfare is implementing Soil Health Management component under National Mission for Sustainable Agriculture. The financial assistance on various components as below is provided under SHM:

- Setting up of new Soil Testing laboratories (STL)(static/mobile/mini labs) and strengthening of existing Soil Testing laboratories
- Training of STL staff/extension officers/ farmers/field functionaries and field demonstrations on balanced use of fertilisers etc
- Promotion and distribution of micronutrients
- Setting up of new Fertilizer Quality Control Laboratories (FQCL) and strengthening of existing state Fertilizer Quality Control Laboratories

7.29 Funds amounting to Rs 44.39 crore have been released till 11th November, 2016 under Soil Health Management component. Comparison of funds released during the current year (till October) with that of previous years is shown below. (Rs. in crore):

7.31 INM & Organic Farming: Ministry of Agriculture, Cooperation and Farmers Welfare, Department of Agriculture, Cooperation & Farmers Welfare is implementing INM & Organic Farming component under National Mission for Sustainable Agriculture. The financial assistance on various components as below is provided under the said components:

- Setting up of mechanized Fruit/ Vegetable market waste/Agro waste compost production units.
- Setting up of State of art liquid/carrier
- Setting up of Bio-fertiliser and Organic fertiliser testing laboratory or strengthening of existing laboratory under FCO.
- Promotion of Organic Inputs on farmer's fields.
- Support to research for development of organic package of practices specific to State and cropping system.
- Setting up of separate Organic Agriculture Research and Teaching Institute (against specific proposal).

Paramparagat Krishi Vikas Yojana (PKVY)

7.32 Paramparagat Krishi Vikas Yojana (PKVY) is one of the schemes under National

Year	2012-13	2013-14	2014-15	2015-16	2016-17 till 15.11.16
Amount	8.51	19.24	63.98	44.39	60.31

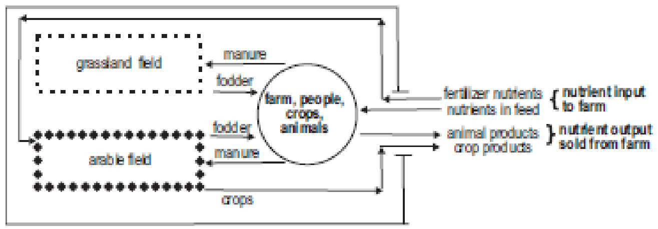
Natural Resource Management

7.36 Agriculture growth can be sustained by promoting conservation and sustainable use of the natural resources through adoption of appropriate location specific measures. Conservation of natural resources in conjunction with development of rainfed agriculture holds the key to meet burgeoning demands for foodgrain requirement of increasing population of the country.

Harvesting the experimental plot for crop cutting

Weighing the Produce

FIGURE 33
Plant nutrient (N, P and K) input/output fluxes on a farm for balance calculation



Source: Finck, 2006.

TABLE 25
Nutrient-related constraints in relation to increasing yield, example of tea in south India

Productivity (kg/ha of made tea)	Limiting factors
Below 800	None
800–1 000	N and K
1 000–2 000	N, P, K, Zn and lime
2 000–3 000	N, P, K, Zn and liming with materials containing Mg
3 000–4 000	N, P, K, Zn, Mg, Si, B, liming, and transport processes within the soil
More than 4 000	N, P, K, Zn, Mg, Si, Mo, B, liming, and transport processes within the soil

Source: Tandon and Ranganathan. 1988.

crpatil-2023

Year- end Review of the Department of Fertilizers-2022

600 Pradhan Mantri Kisan Samridhi Kendra opened to act as “One Stop Shop” for all the agriculture related inputs and services

Under One Nation One Fertilizers - “Pradhanmantri Bhartiya Janurvarak Pariyojna” implemented

Posted On: 23 DEC 2022 4:16PM by PIB Delhi

(Figures in LMT)

Year	Import of Fertilizers				
	Urea	DAP	MOP	NPKS	Total
2022-23	46.13	47.81	15.02	19.43	128.39

(Figures in ‘LMT’)

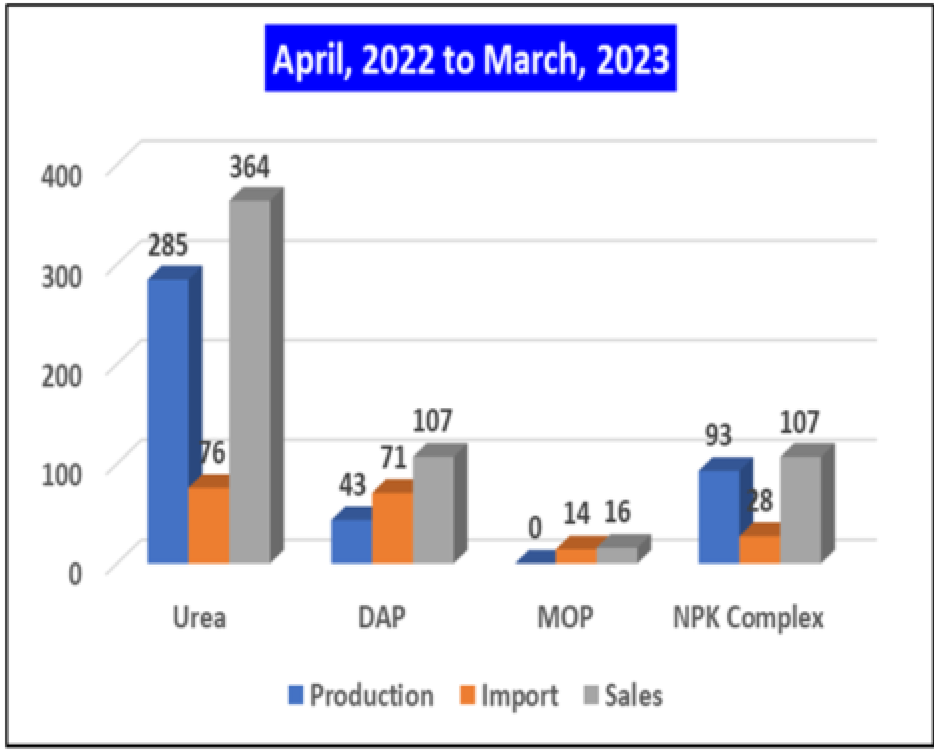
Year	Production of Fertilizers					
	Urea	DAP	MOP	NPKS	SSP	Total
2022-23	187.21	27.41	-	67.21	38.94	320.76

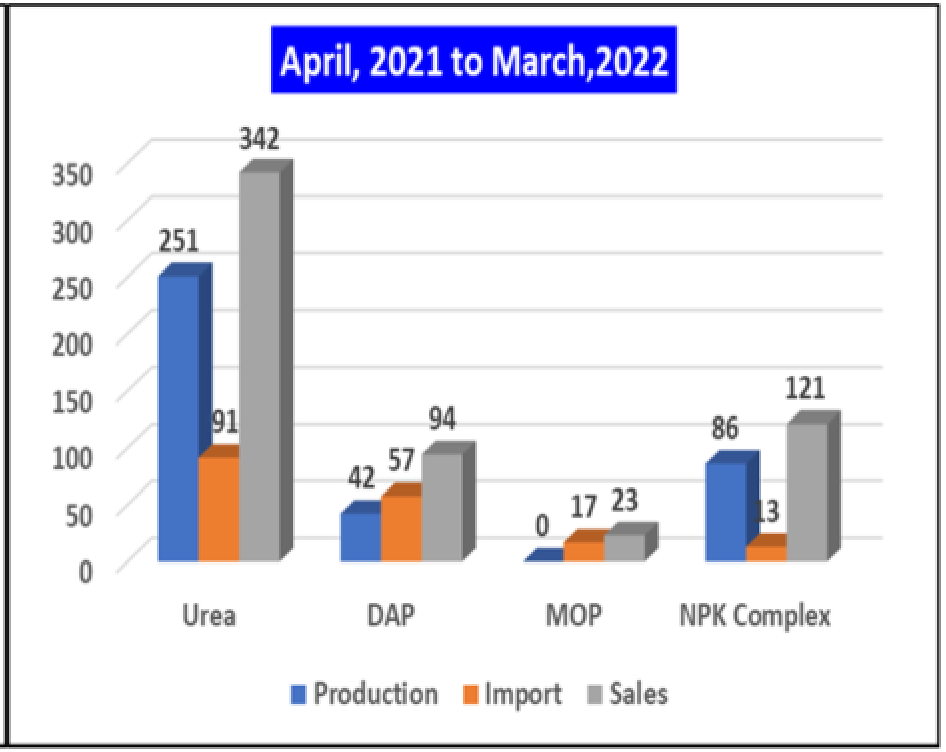
(Figures in ‘LMT’)

Year	Consumption of Fertilizers				
	Urea	DAP	MOP	NPKs	Total
2022-23	232.54	83.53	11.23	74.16	401.46

FertiliserIndia

Fertilizer Production, Import & Sales in India (Qty. in Lac Tons)





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Annual Nitrogen input and out flow million metric tonnes

Inputs
Fixation 149-180
Amendments 40 50
Atmospheric deposition 5
Erosion input 214-262

Out flow
Denitrification 150-185
Volatalization 26-53
Leaching/ Run off 10-40
Erosion losses 160-225

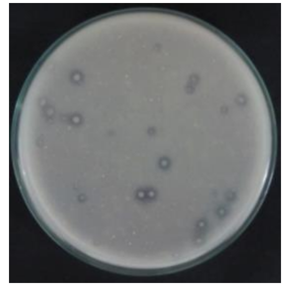
In India annually we harvest about 16-18 m.t N_2 and we add about 12- 14 m.t. of N_2 causing a deficit of about 2- 6 m.t .

Our current fertilizer requirement is about 40-42 million metric tonnes while our production is about 32-34million metric tonnes.

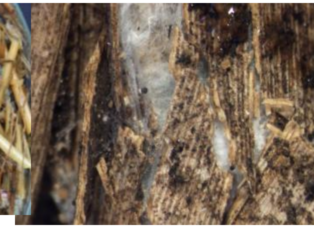
Status of one fertilizer- UREA

- Production < Consumption
- Use efficiency 25-30 % -Declining crop response.
- Cost of production increases every year (22,500 Kcal per Kg of Urea production and distribution)
- Not taken in its parent form- Only mineralization and nitrification-microbial
- Environmental hazard- Eutrification, nitrification, denitrification, volatilization (Global warming) and leaching losses- Ground water contamination, Methemoglobinemia.

Microbes in Agriculture


- **Recycle chemical elements and mobilize nutrients to plants**
- **Decompose organic matter**

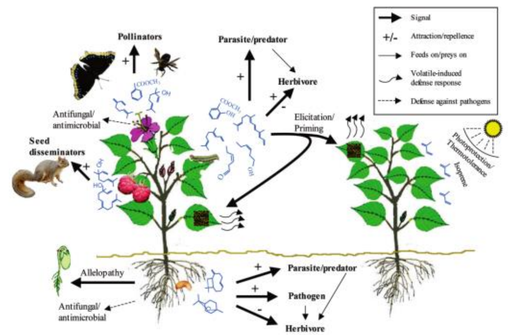



- For control of insect pests and disease causing agents- Biological control


- In production of BIOFUELS- Biogas
- Bioplastic

- Plant Growth Promotion
- Bioremediation

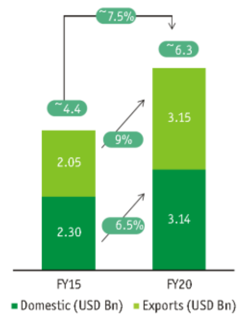
➢ **Biopesticides**
➢ **Effective microorganisms**
➢ **Biofertilizers**



Indian Agriculture …

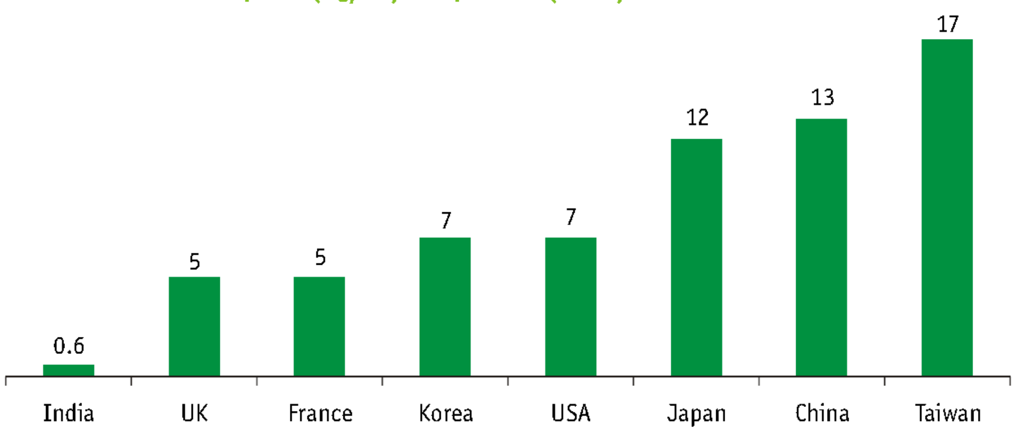
- Presently 273.7 MT of food grains are produced from 142.3 million hectares of agriculture land (68 % of population 14 % to GDP)
- 540 lakh metric tons of synthetic chemical fertilizers
- 45,000 metric tons active molecules of synthetic pesticide
- 50 thousand tons of biofertilizer and around
- 700 metric tons of biopesticides.

Figure 1: Indian Crop Protection Market (USD Billion)



Source: Analysis by Tata Strategic

Figure 6: Pesticide consumption (Kg/ha) comparison (FY 15)

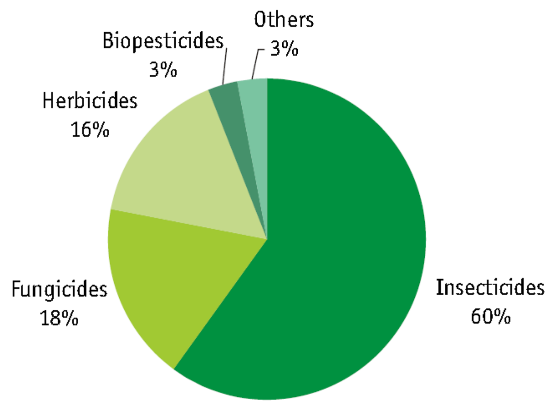


Fourth largest global producer of agrochemicals after the US, Japan and China, Among the lowest in the world in terms of per hectare consumption of pesticides at 0.6 kg/ha

Indian Agriculture …

India has process technology for 60 generic molecules
Agrochemicals worth 4.1 billion $ are to go off patent by 2020
Top 6 importing countries constitutes India's 44 per cent agrochemical export

Figure 2: Indian Crop Protection Market Split (FY15)



- **Agricultural production is marginal despite increase in pesticide consumption @ 20% annum**
- **Loss due to pests and diseases is over 8 Billion USD$ / annum**
- **Rejections of Indian export by 84.6 Billion USD$ / annum due to pesticide residue**
- **Farmers distress due to debts.**

Emphasis on agriculture

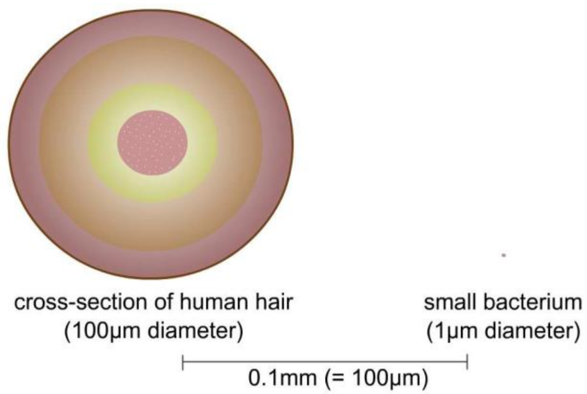
1. Increase productivity
2. Sustain productivity
3. Ecological approach
4. Regenerative

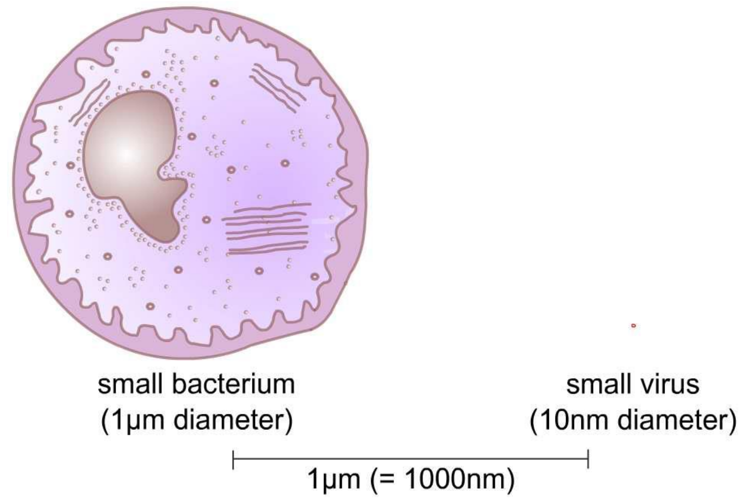
Microbial Resources

Least explored

Less than 1 percent of potential diversity known yet provides the highest utility.

- Bacteria
- Fungi
- Viruses
- Single cell algae
- Protozoa





Hosts of *Nomuraea rileyi*

Spodoptera litura

Helicoverpa armigera

Thysanoplusia orechalcea

Agrotis ipsilon

Chilo partellus

Mythimna separata

Achroentia styx

Sucking pests infected by *Lecanicillium lecanii*

Infected aphid

Infected mealy bug

Infected thrips

Infected spiralling whitefly

Infected mite

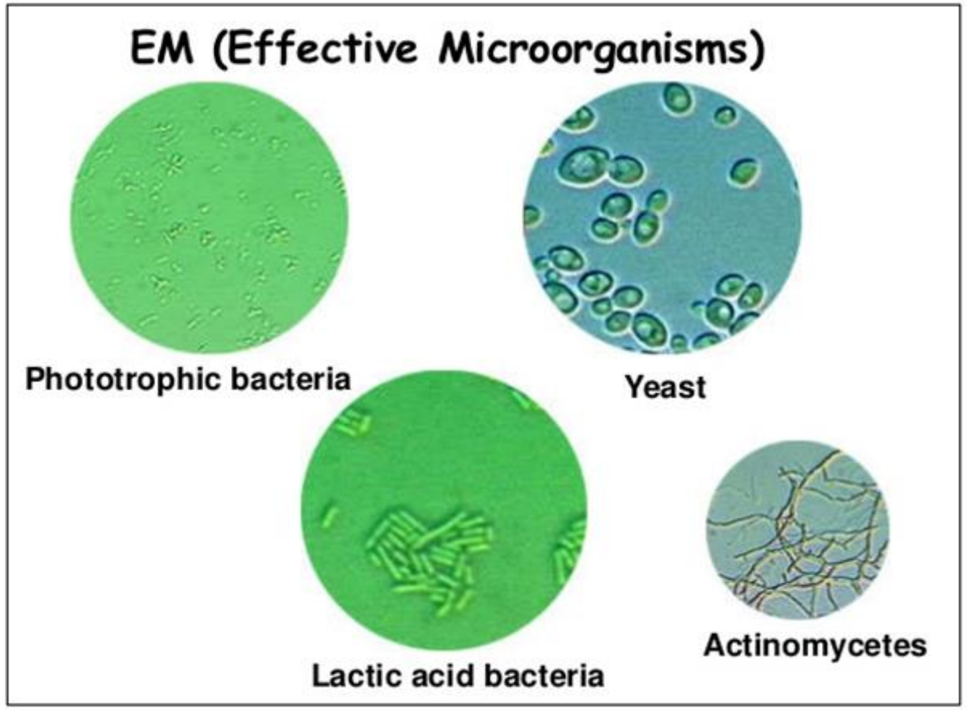
EFFECTIVE MICROORGANISMS (EM)

- ✓ **Mixed cultures of effective microorganisms (EM) now referred to as EM technology 1980s by Teruo Higa, a professor in the University of the Ryukyus, Okinawa, Japan (Higa,1991).**
- ✓ **It provides a means of controlling soil microorganisms to the advantage of the plant.**
- ✓ **EM can add a dimension that enhances the probability for successful transition from conventional to nature farming methods.**
- ✓ **He discovered a specific group of naturally occurring beneficial microorganisms with an amazing ability to revive, restore, and preserve soil health.**
- ✓ **He named this group Effective microorganism.**

EFFECTIVE MICROORGANISMS (EM)

Include lactic acid bacteria, photosynthetic bacteria, actinomycetes, yeast and mycorrhizal fungi.
Through useful fermentation these organisms produce organic acids, plant hormones (e.g., auxin, gibberellins and cytokinin), vitamins and antibiotics.
These products of microbial metabolism can benefit the growing plant by a) solubilizing nutrients of limited solubility,e.g.,

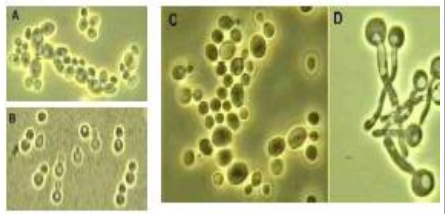
a) rock phosphate,
b) complexing heavy metals to limit their uptake by plants
c) providing simple organic molecules such as amino acids for direct uptake
d) protecting the plant from soil-borne pathogens, insects and diseases
e) stimulating plant growth and increasing the yield and quality of crops and
f) improving the chemical and physical properties of soils.



Effective Microorganisms -Organic Manures

- ✓ **Compost**
- ✓ **Vermiwash**
- ✓ **Biodigestr**
- ✓ **Panchagavvya**
- ✓ **Beejamruth**
- ✓ **Jeevamruth**
- ✓ **Organic Manures**

Yeast organisms



Synthesise anti-microbial and other useful substances required for plant growth from amino acids and sugars secreted by photosynthetic bacteria, organic matter and plant roots. Produce bio-active substances such as hormones and enzymes that promote active cell and root division.

Lactobacillus bacteria

Produce lactic acids from the sugars and other carbohydrates developed by photosynthetic bacteria and yeast. Strong sterilising compound and suppresses harmful micro-organisms and enhances the decomposition of organic matter.

Jeevamruth

Biodigester

Table 1. Bacterial richness, evenness and diversity at developmental stages of panchagavya calculated based on DGGE fingerprint.

Stages of panchagavya	Number of OUT's	Range weighted richness	Pielou's evenness index	Shannon diversity index
3rd Day sample	27	209.58	0.84	2.74
7th Day sample	28	228.92	0.84	2.80
15th Day sample	28	181.88	0.88	2.96
21st Day sample	23	114.79	0.89	282
30th Day sample	23	122.11	0.74	2.35

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Bacterial Community Analysis of Soybean (*Glycine max*) Sprayed with Panchagavya Revealed by DGGE

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Bacterial Succession During Panchagavya Making as Revealed by DGGE Analysis

Biradar Balasaheb Gunwantrao[1] and C.R. Patil[2]

[1]Department of Biotechnology, University of Agricultural Sciences Dharwad, India.
[2]Department of Agricultural Microbiology, Institute of Organic Farming, University of Agricultural Sciences Dharwad, India.

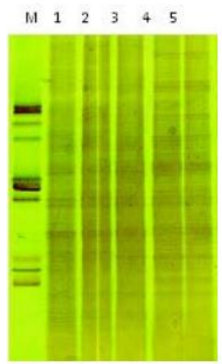


Fig. 2. PCR-DGGE profile of panchagavya bacterial species samples drawn on 1- 3rd day, 2- 7th day, 3- 15th day, 4- 21st day and 5- 30th day old panchagavya samples. 16S rDNA amplified by PRBA338GC and PRUN518 primers was separated in 12 % polyacrylamide gel containing 30%-70% denaturant and silver stained

BIOFERTILIZERS

Biofertilizers are the preparations containing primarily active strains of living microorganisms which colonize the rhizosphere or interior of the plant and promote growth by increasing the supply or availability of primary nutrients and growth regulators to the target crop when applied to seed, plant surface or soil (Vessey, 2003).

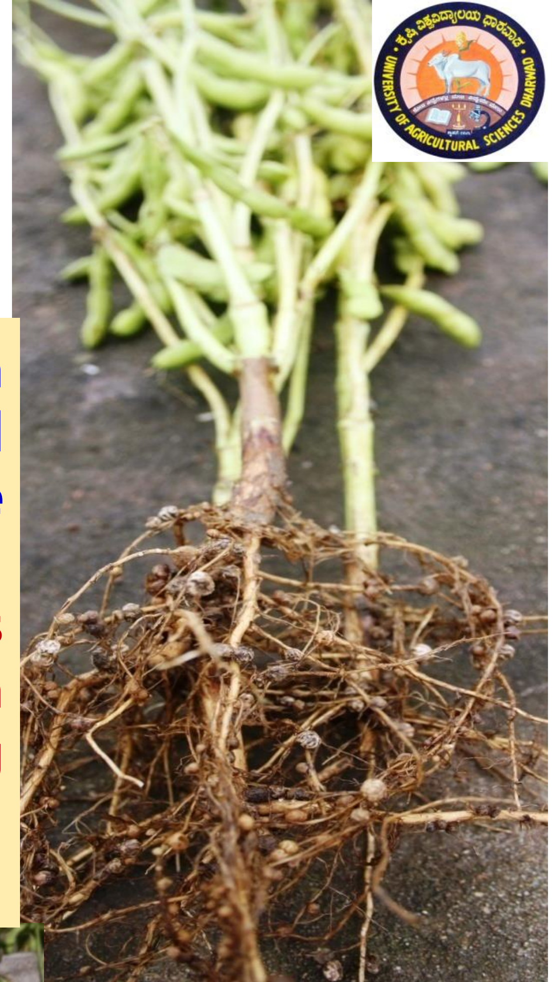
Sl. No.	Name of the Diazotroph	Associated crop plants /partners	Name of the biological nitrogen fixing (BNF) system
1	Rhizobium	Legume crops and some oil seed legumes	Legume –Rhizobium symbiosis
2	Frankia	Non legume tree species such as Alnus, Casuarina, Myrica, Alder Allocasuarina, Hippophaee, etc	Actinorhizal symbiosis
3	Anabaena	Azolla an aquatic fern	Anabaena-azolla symbiosis

Pea Plant

R. leguminosarum nodules

Pink color is leghaemoglobin a protein that carries oxygen to the bacteroids

·Rhizobium

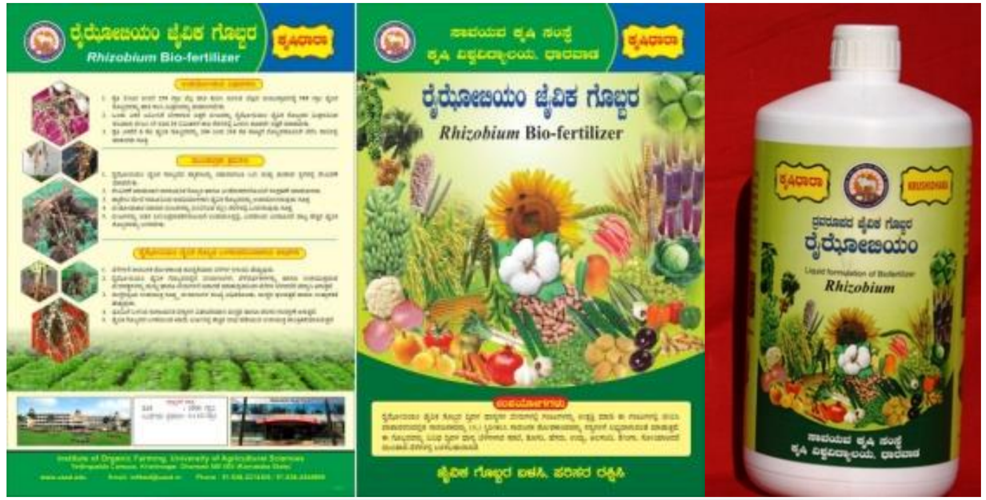


Fixes atmospheric nitrogen a minimum of 12-15 kg and upto 60-80 kg N per acre per season

Afetr harvest of crops mineralization released a minimum of around 6-8 kg N per acre

Rhizobium – legumes

- *Rhizobium* and *Bradyrhizobium.*
- Root nodules.
- Host specific.
- *R. leguminosarum* Pea.
- *R. phaseoli* Bean.
- *R. trifolii.* Clover
- *R. meliloti* Alfalfa
- *R. lupini* Lupini
- *B. japonicum* Soybean
- *R. sp.* Cowpea



Green Biomass:

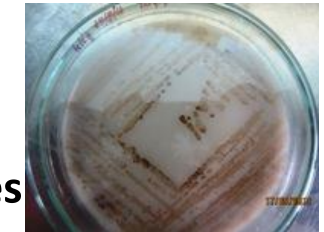
Per acre 8-10 tons Biomass and 12-15 kg N

Broad Groups - Based on the nutrient they mobilize

Nitrogen fixing biofertilizers



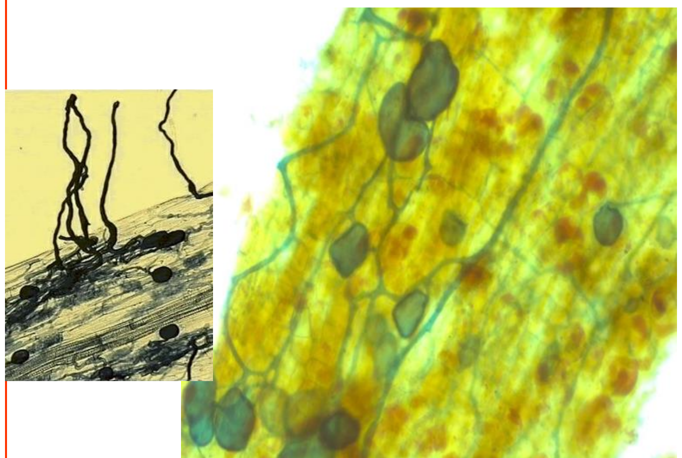
1. Rhizobium – Legume
2. Azorhizobium
3. Sinorhizobium
4. Azospirillum - Cereals
5. Azotobacter- Plantation crops vegetables
6. Gluconacetobacter
7. Frankia
8. Blue Green Algae
9. Azolla





PHOSPHATE SOLUBILIZING AND MOBILIZING BIOFERTILI

- MICROBIAL SOLUBILIZATION OF INSOLUBLE PHOSPHATE IN SOIL
- MICROBES SOLUBILIZING PHOSPHATE INCLUDE SPECIES OF FUNGI, BACTERIA, YEAST, ACTINOMYCETES AND BLUE GREEN ALGAE
- CARRIER BASED AND GRAIN BASED PRODUCT

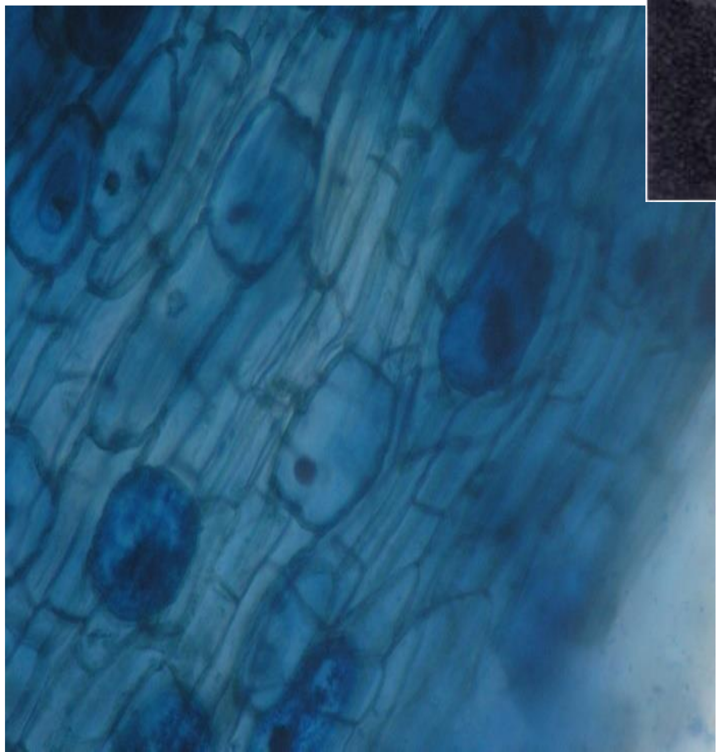


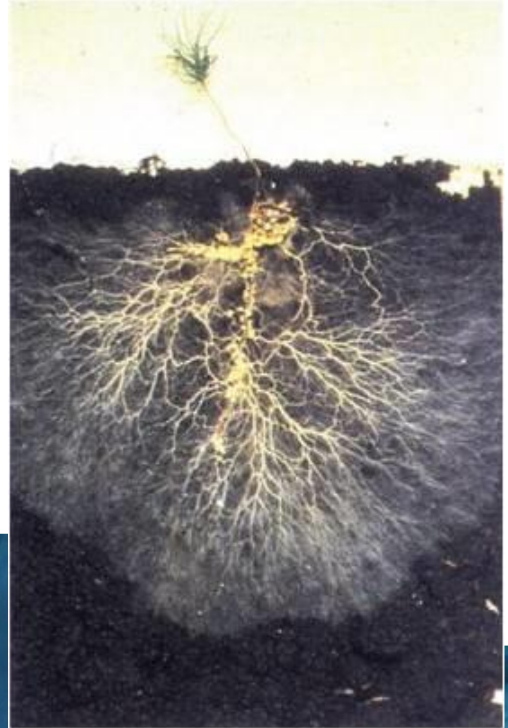
VA-Mycorrhizal fungi

PSB- *Bacillus megaterium*
Pseudomonas striata
Burkholderia cepacia
Serratia
Fluorescent pseudomonads

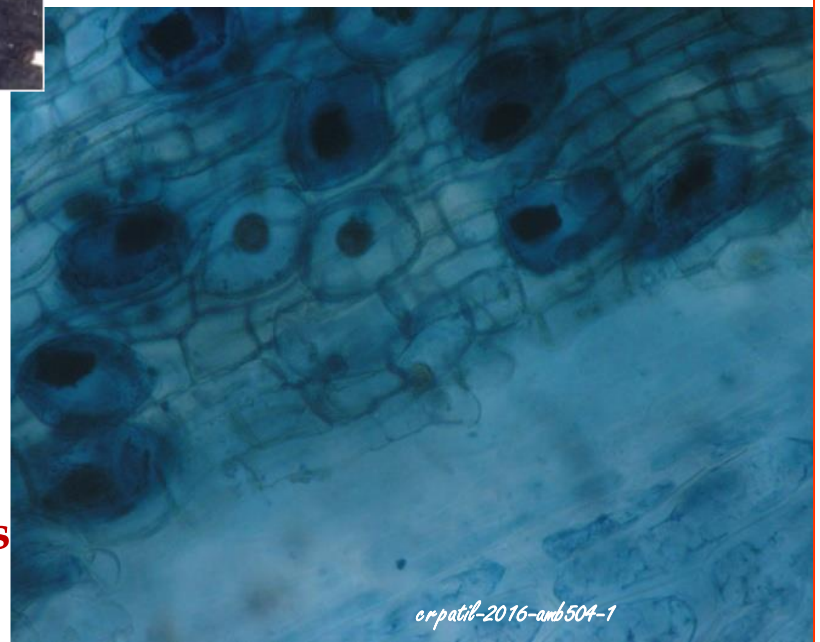
PSF- *Aspergillus*
Penicillium

Phosphorus mobilizers

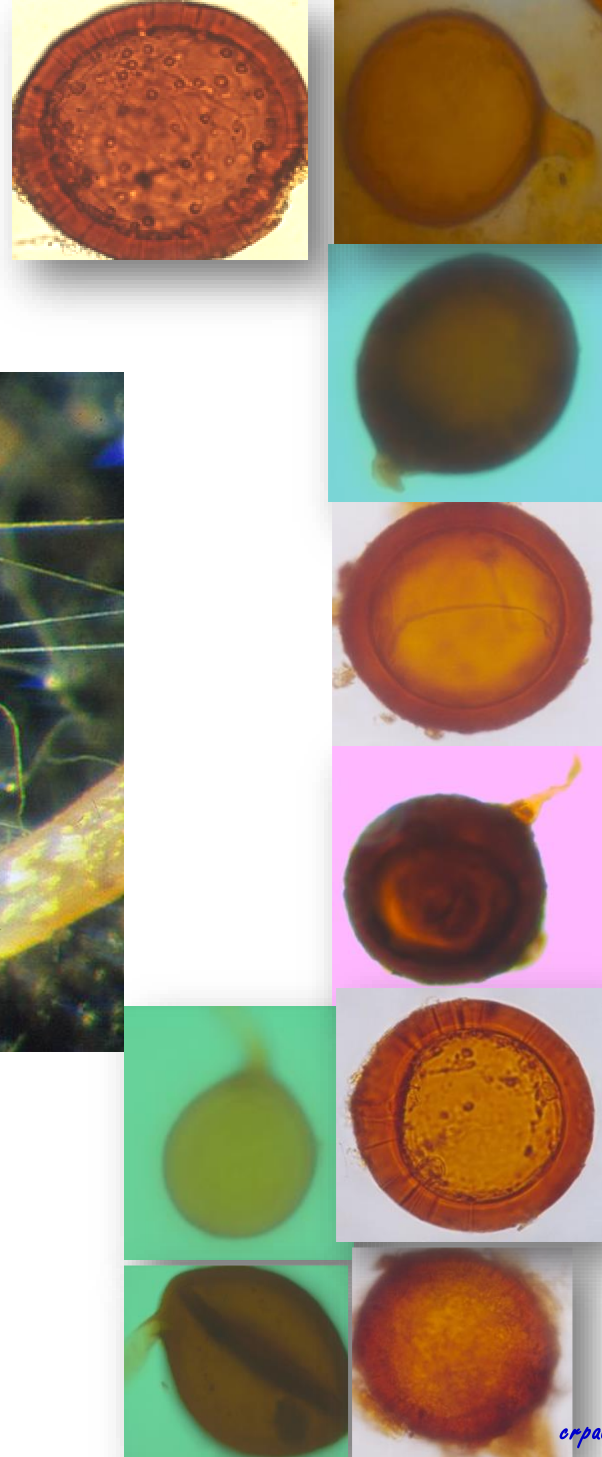




Mycorrhizal roots



Mycorrhizal biofertilizer



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UNIVERSITY OF AGRICULTURAL SCIENCES DHARWAD

Gluconacetobacter diazotrophicus.

Can fix 150–180 k.g N per hectare per season.







Seed treatment






Seedling dip

In main field apply in furrows by mixing 8 kgs of biofertilizer with 200-250 kg of manure.

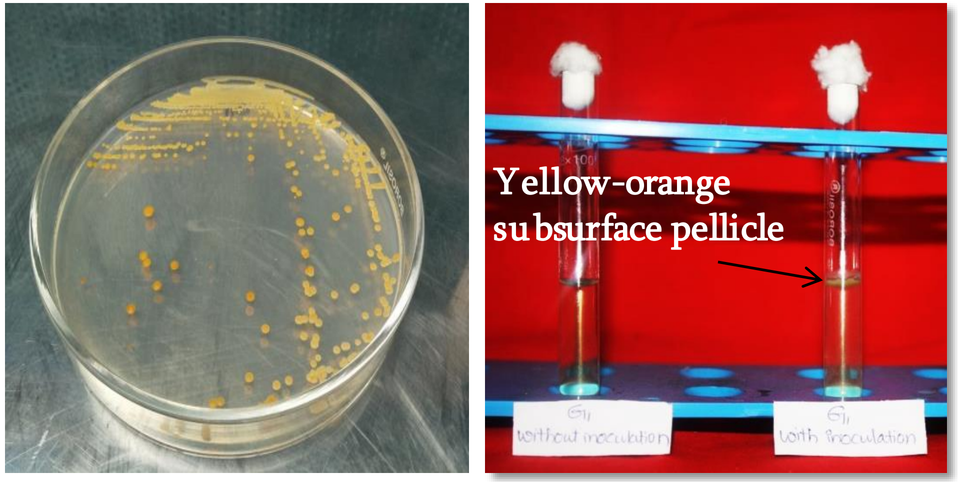

17/11/2007


17/11/2007

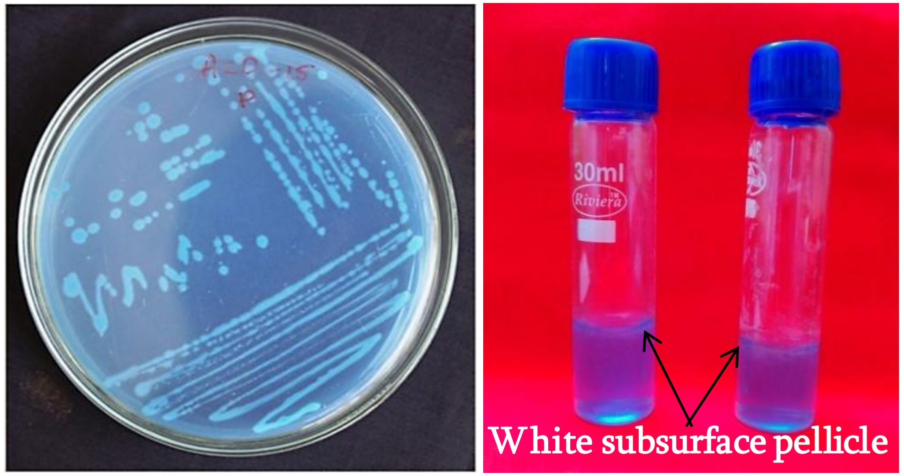

Sprays
17/11/2007


17/11/2007

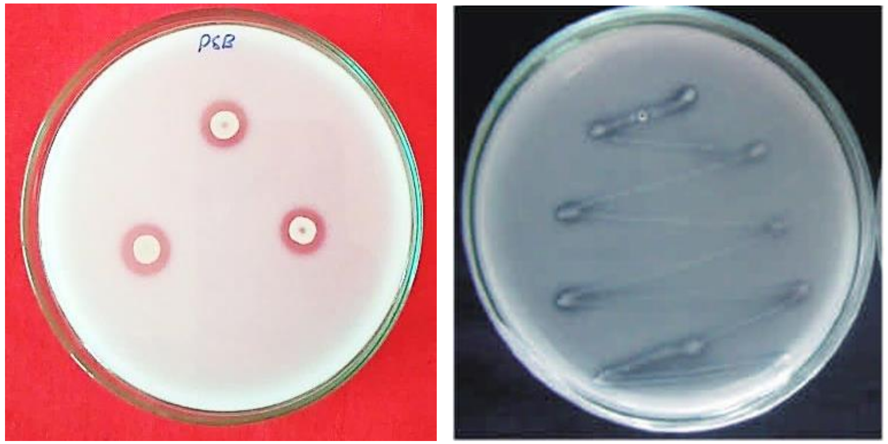
NPK consortia of biofertilizer including N_2 fixing, phosphate solubilising bacterium (*Psuedomonas striata)* and potash solubilizing bacterium (KSB)



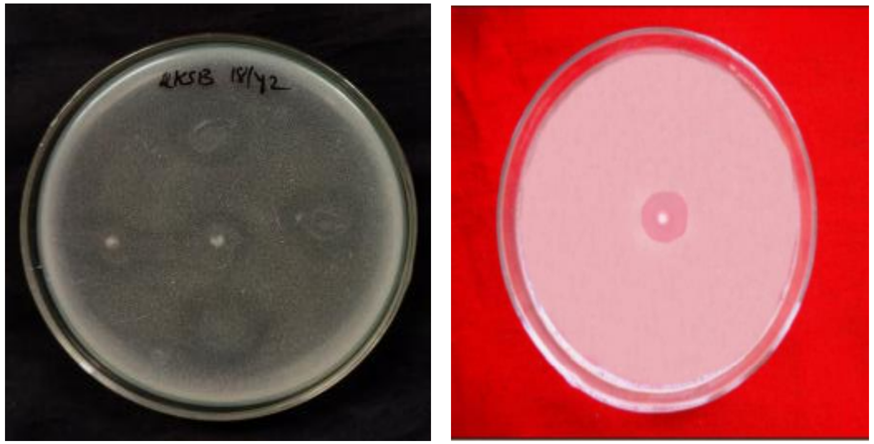
Gluconacetobacter G1



Azospirillum ACD-15



PSB



KSB

Different biofertilizer strains used in one formulation

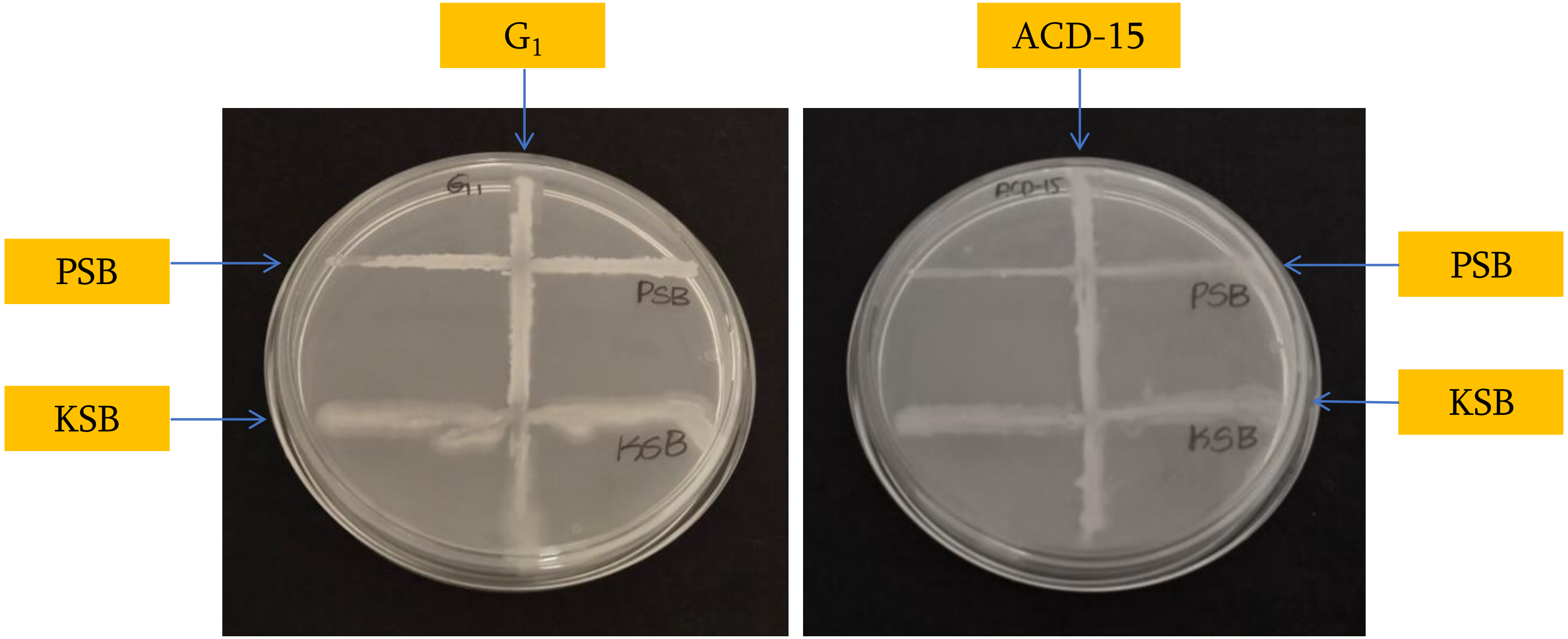


Plate 2 : Compatibility test of biofertilizer strains

Table 1: Proportion of the three microbial inoculants in formulations of two different microbial consortia in 1:1:1 ratio

Sl. No.	Microbial consortia	Different formulations developed	Volume of microbial inoculants in Microbial consortia (ml)			Total volume (ml)
			G_1/ACD-15	PSB	KSB	
1	MC-1	Lignite, Kaolinite, Bentonite, Na-alginate	1.83 (G_1)	4.24	60.61	66.68
2	MC-2	Lignite, Kaolinite, Bentonite, Na-alginate	24.09 (ACD-15)	2.81	40.16	67.06
3	MC-1	Liquid	4.63 (G_1)	10.37	185.18	200.18
4	MC-2	Liquid	4.63 (ACD-15)	30.37	165.18	200.18

Note-
MC1 : Microbial consortium-1 (G_1+PSB+KSB)
MC2 : Microbial consortium-2 (ACD-15+PSB+KSB)

Development of Microbial Based Agro-Waste Management Technology for Enhancing Crop Productivity, Improving Soil Health and Increasing Farmers Income

- **Formulations prepared:**
- **Lignite based**
- **Liquid formulations**
- **Kaolinite based formulations**
- **Alginate based formulations**

GOVERNMENT OF KARNATAKA
(DEPARTMENT OF AGRICULTURE)

FORM 'A2'
ACKNOWLEDGEMENT
(STATE WHOLE SALE)
[See Clause 8 (3)]

DR C R PATIL HEAD

Registration No - FE19-20134382
Certificate No - JDA/F&PP/KAR/FE19-20125533/2022-2023
Date of Issue - 20/05/2022
Valid Upto - 19/05/2027

Received from INSTITUTE OF ORGANIC FARMING UAS DHARWAD , INSTITUTE OF ORGANIC FARMING UNIVERSITY OF AGRICULTURAL SCIENCES DHARWAD , a complete Memorandum of Intimation along with Form O, fee of Rs. 25000 /- bearing SBI(Govt.), SBI UAS CAMPUS BRANCH , Dated 14/03/2022 .

This acknowledgement shall be deemed to be the letter of authorization entitling the applicant to carry on the business as applied for, for a period of 5 years from the date of issue of this Memo of acknowledgement unless suspended or revoked by the competent authority.

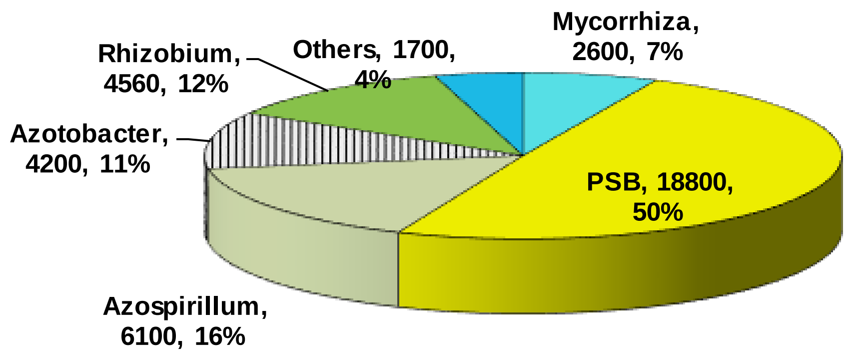
DR C R PATIL , PROFESSOR AND HEAD INSTITUTE OF ORGANIC FARMING UNIVERSITY OF AGRICULTURAL SCIENCES DHARWAD , Email-id: iofdwd@uasd.in , Mob. No: 9448013373 is the responsible officer as per clause 24 of FCO, 1985.

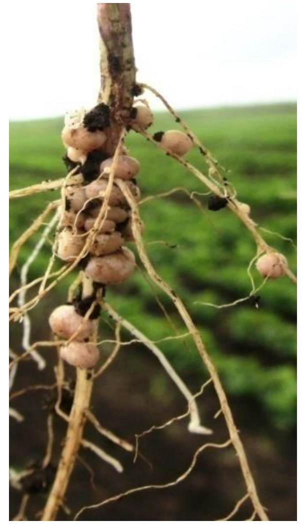
Biofertilizers in India

Ministry of Agriculture

Department of Agriculture and Cooperation, Government of India, New Delhi, included biofertilizers and organic fertilizers under section 3 of the Essential Commodities Act, 1955 (10 of 1955), in Fertilizer Control Order (FCO), 1985.

Share of different biofertilizers to total production (2010-11)





Production 52,000 tons against estimated requirement of 5,34,000 tons

Current coverage 22-24 per cent area and the usage is increasing at about 8- 10 per cent annually

Biofertilizers and Organic Fertilizers Covered in Fertilizer (Control) Order, 1985 (Amendment, March 2006 and further amendment November 2009)

General Rules

Ministry of Agriculture, Department of Agriculture and Cooperation, Government of India, New Delhi, vide their order Dated 24th March, 2006 included biofertilizers and organic fertilizers under section 3 of the Essential Commodities Act, 1955 (10 of 1955), in Fertilizer (Control) Order, 1985. These rules were further amended in respect of applicability, specifications and testing protocols vide Gazette notification 3 November, 2009.

National Centre of Organic Farming

Department of Agriculture and Cooperation,

Ministry of Agriculture, Govt of India,

CGO-II, Kamla Nehru Nagar

Ghaziabad, 201 001, Uttar Pradesh

The FCO quality standards for different biofertilizer formulations in India

Sl. No.10	Biofertilizers	Base	Viable cell count	Efficiency character
1	*Rhizobium*	Carrier based in the form of moist / dry powder of granules, or liquid	CFU minimum 5x10^7 cell/ g of powder, granules or carrier material or 1x10^8 cell/ml of liquid	Should show effective nodulation on all the species listed on the packet
2	*Azotobacter*	Carrier based in the form of moist / dry powder of granules, or liquid	CFU minimum 5x10^7 cell / g of powder, or carrier material or 1x10^8 cell/ml of liquid	The strain should be capable of fixing at least 10mg of nitrogen per g of sucrose consumed
3	*Azospirillum*	Carrier based in the form of moist / dry powder of granules, or liquid	CFU minimum 5x10^7 cell / g of powder, or carrier material or 1x10^8 cell/ml of liquid	Formation of white pellicle in semi- solid free bromothymol blue media
4	Gluconacetobacter diazotrophicus	Carrier based in the form of moist / dry powder of granules, or liquid	CFU minimum 5x10^7 cell / g of powder, granules or carrier material or 1x10^8 cell/ml of liquid	Should be efficient N_2 fixing strain both under lab and field conditions.
5	Phosphate Solubilizing Bacteria (PSB)	Carrier based in the form of moist / dry powder of granules, or liquid	CFU minimum 5x10^7 cell / g of powder, granules or carrier material or 1x10^8 cell/ml of liquid	The strain should have phosphate solubilizing capacity in the range of minimum 30%, when tested spectrophotometerically. In terms of zone formation, minimum 5mm solubilisation zone in prescribed media having at least 3 mm thickness.
6	Phosphate Solubilizing Fungi (PSF)	Carrier based in form of moist / dry powder of granules, or liquid	Spore count per ml /gram should be Minimum 1x 10^6 per gram solid or 1x 10^7 viable spores per ml of liquid	The strain should have phosphate solubilization in the range of 30% when tested spectrophotometrically. Minimum 10 mm solubilisation zone in prescribed media having at least 3 mm thickness
7	Potash Mobilizing Bacteria (PMB)	Carrier based in the form of moist / dry powder of granules, or liquid	CFU minimum 5x10^7 cell / g of powder, granules or carrier material or 1x10^8 cell/ml of liquid	Minimum 10 mm solubilisation zone in prescribed media having at least 3 mm thickness.
8	Zinc solubilizing Bacteria (ZnSB)	Carrier based in the form of moist / dry powder of granules, or liquid	CFU minimum 5x10^7 cell / g of powder, or carrier material or 1x10^8 cell/ml of liquid	Minimum 10 mm solubilisation zone in prescribed media having at least 3 mm thickness.
9	Mycorrhizal Biofertilizer	Fine powder / tablets/granules/root biomass mixed with growing substrate	Total viable propagules / gm of product, minimum should be 100/ gm of finished product	80 infection points in test roots/gm of mycorrhizal inoculums used
10	Carrier based NPK consortium Liquid NPK consortium	Carrier based in the form of moist / dry powder of granules, or liquid	CFU minimum 5x10^7 cell / g of powder, or carrier material or 1x10^8 cell/ml of liquid	Each property of strain verified

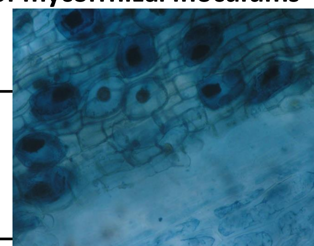
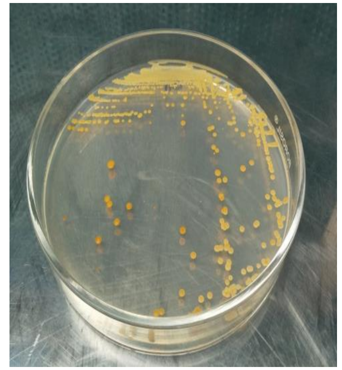



Table . Common Biofertilizers recommended for various crops in India as follows

Biofertilizer	Crop for which recommended	Anticipated benefits
Rhizobium	**Pulses**: Chickpea, pea, lentil, black gram, green gram cowpea, pigeon pea, Oilseeds: Soybean, groundnut	19-22 kg N
	Fodder: Berseem, Lucerne	50-80 kg N
Azotobacter	Cereals, millets, cotton, mustard, vegetables, flowers	15-20 kg N
[illegible]	[illegible] oculant for legumes	20 kg N
[illegible]	[illegible]	25-30 kg N
[illegible]	[illegible]	3kg/t
[illegible]	[illegible]	25 kg P_2O_5

Nutrient contribution by different biofertilizers

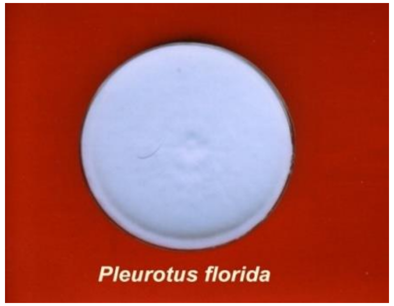
- Nitrogen fixers
  - Rhizobium — 30-60kg N/ha
  - Azotobacter — 20 kg N/ha
  - Azospirillum — 20-25 kg N/ha
  - Acetobacter — 35-60 kg N/ha
- P-Solubilizers — 10-15 kg P_2O_5/ha
- K-Solubilizers — 10-15 kg K_2O/ha

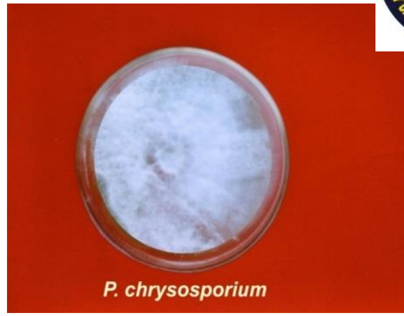


- **Let us assume combined application of NPK shall contribute minimum of 30 kg NPK under poor soils or 30% of RDF under ideal soils**

Compost culture and its application


Trichoderma viridae


Pleurotus florida


P. chrysosporium


Aspergillus sidowia

Used @ 1-1.5 kg per tonne of residue and applied as slurry on layers of residue


ಕಾಂಪೋಸ್ಟ ಕಲ್ಚರ್
(Compost Culture)
ಕಾಂಪೋಸ್ಟ ಕಲ್ಚರ್
(Compost Culture)


23/09/2015


ಕಾಂಪೋಸ್ಟ ಕಲ್ಚರ್
(Compost Culture)


09/07/2015
crpatil-2016-amb504-1

Method of application

Available as 4 x 250 g packets

Make slurry by mixing contents of one kg (4 x 250 g) in about 12-14 ltrs. of water


Apply the slurry by sprinkling one a layer of residue

In about 12 weeks the residue are converted to good quality manure (about 50%)

1500 farm families 11 tons of compost culture supplied


26/11/2020 01:27


26/11/2020 02:16


08/01/2021

Current Journal of Applied Science and Technology

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ISSN: 2457-1024
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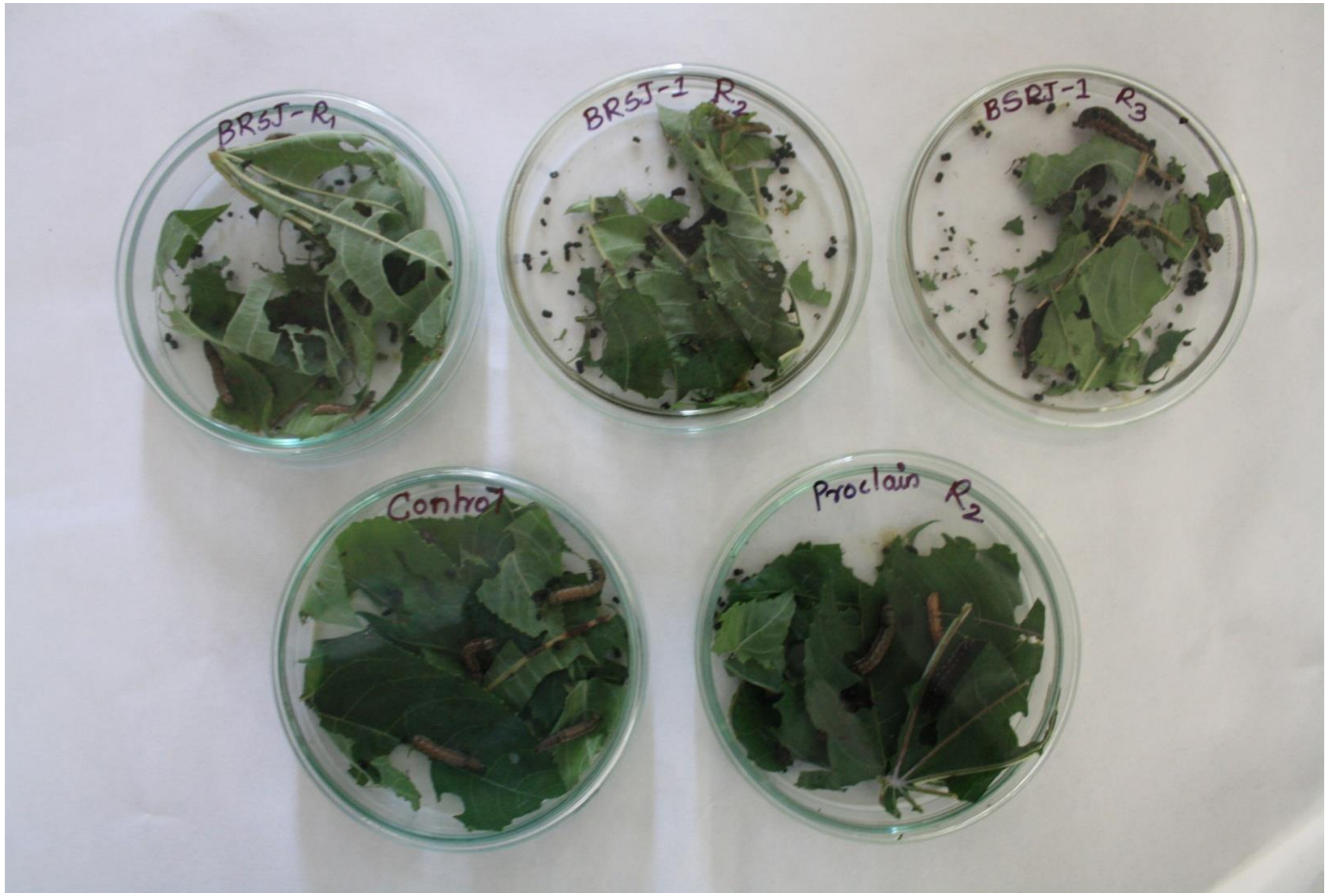
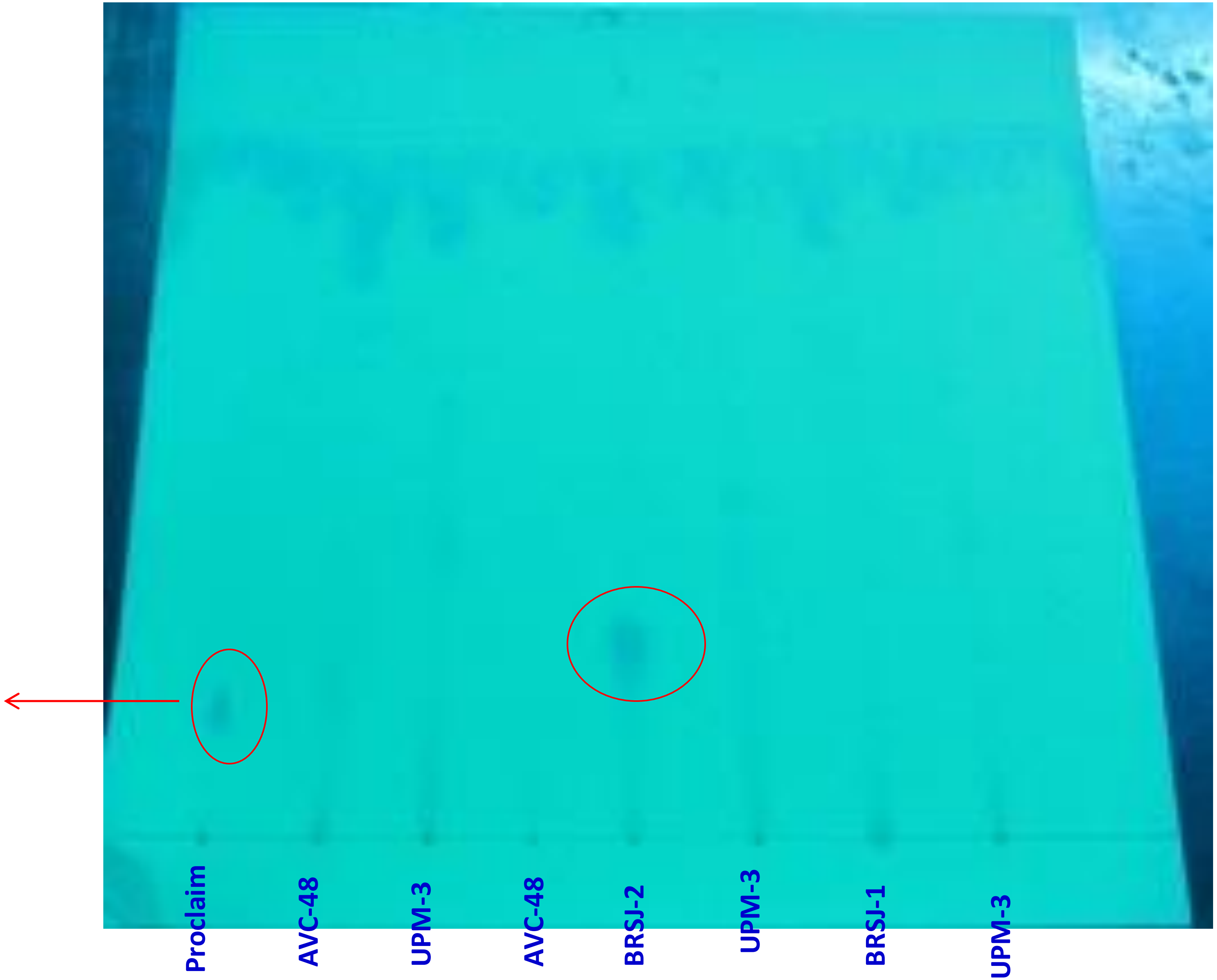
Farm Waste Recycling Using Consortium of Lignocellulolytic fungi- A Farmers Participatory Approach

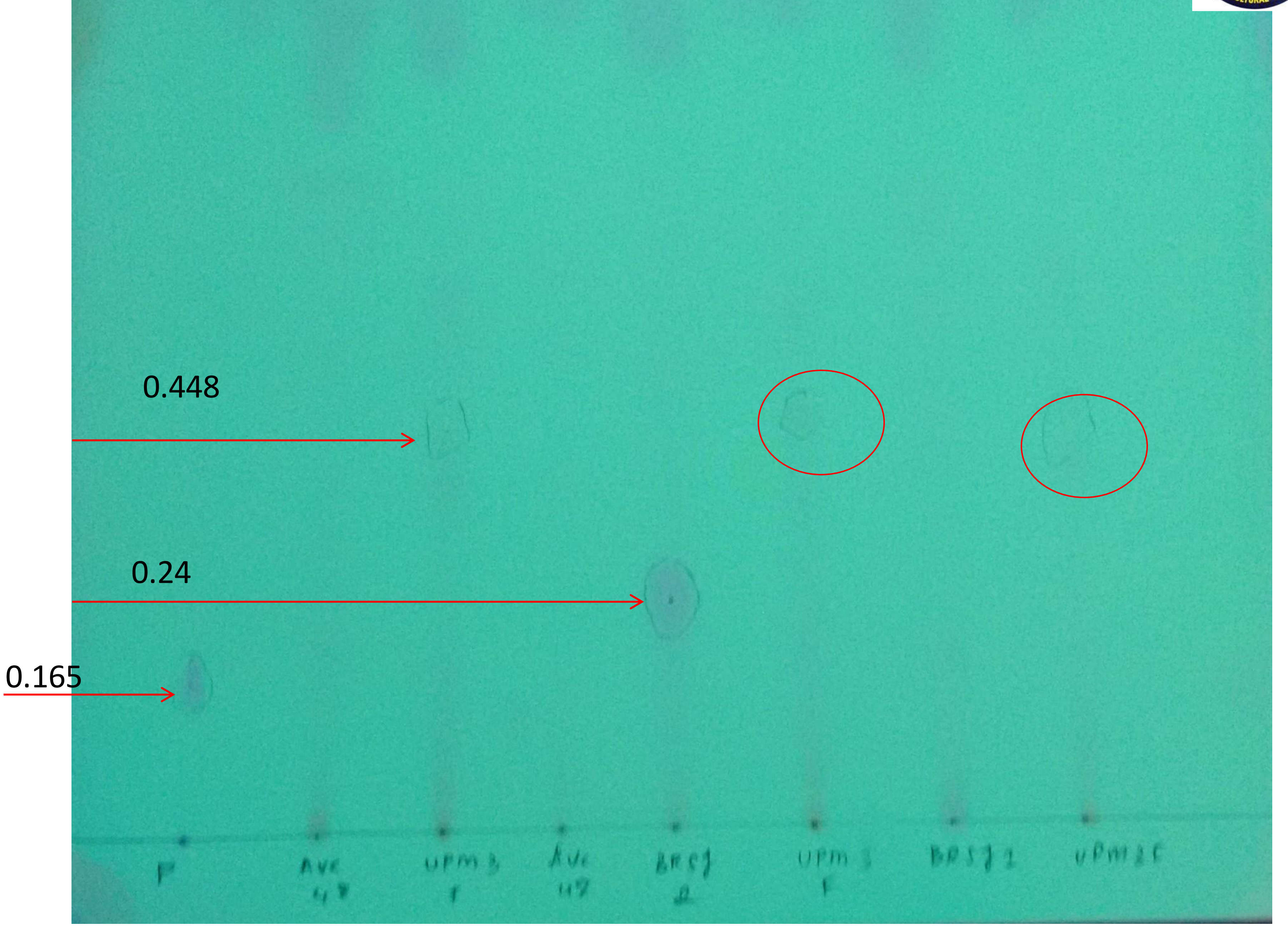
C. R. Patil[1*], K. S. Jagadeesh[2], G. Srinivasalu[3] and G. V. Dasar[4]

Endophytes with insecticidal metabolites




Proclaim
AVC-48
UPM-3
AVC-48
BRSJ-2
UPM-3
BRSJ-1
UPM-3

Separation of metabolites using TLC

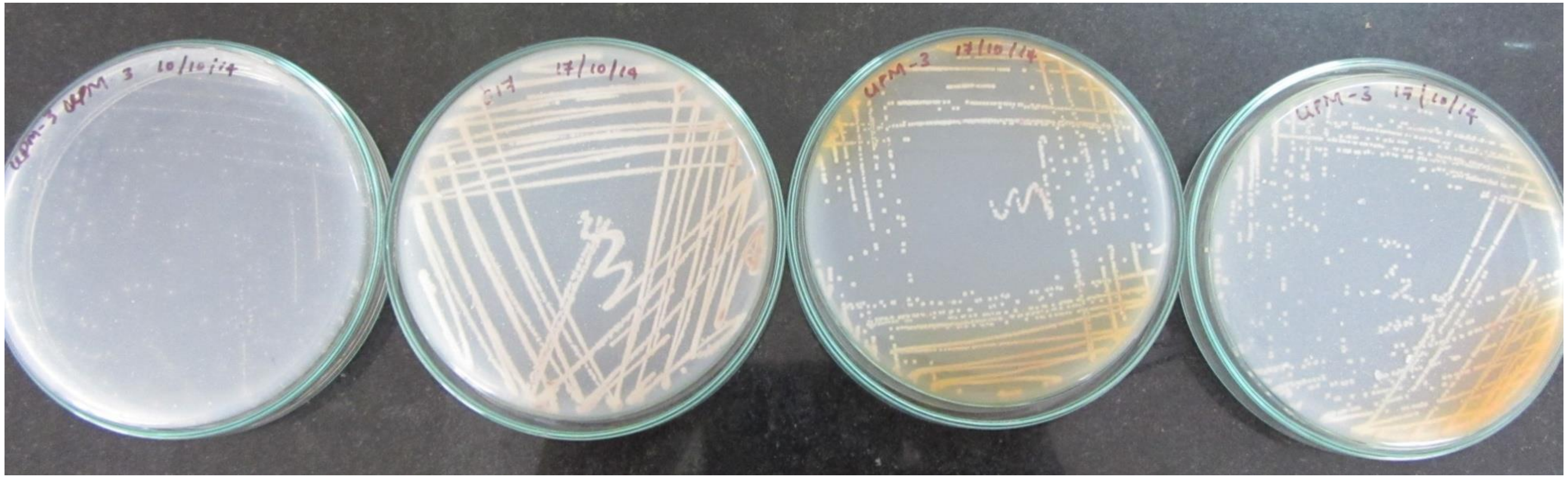


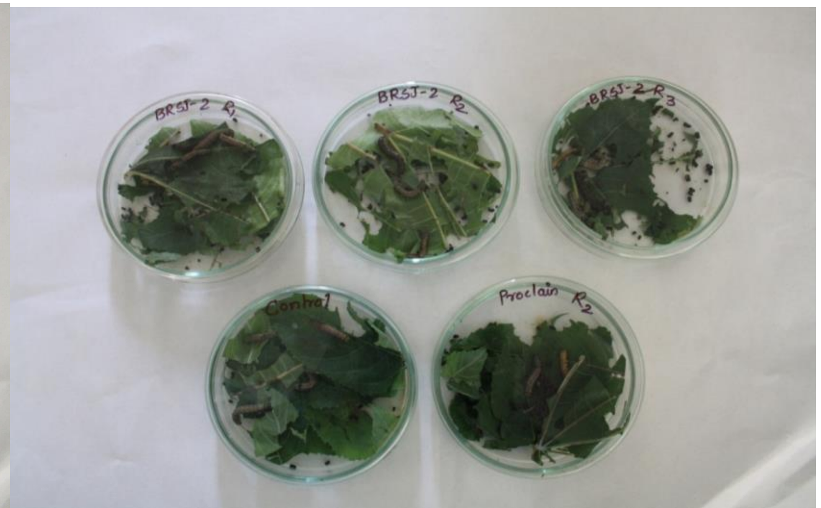
Finger printing of efficient PGPMs

Name of isolate	Closest related strain	Percent homology
AVC-4	*Ochrobacterium tritici*	90
BRSJ-1	*Achromobacter xylosoxidans*	90
UPM-3	*Achromobacter xylosoxidans*	90

Newer horizons :

Screening of Actinomycetes for their ability to control insect pests





Root length of *Nothapodytes nimmoniana* as influenced by inoculation with endophytic bacteria 200 days after inoculation

4. Seed endophytes of *Striga* as biocontrol agents

Emergence of Striga was not seen until first week of March in treated plots emergence was seen in untreated plots, haustoria of *Striga* were visible from 100-120 days

Sl. No.	Treatment	Average number of striga observed
1	PSC7	17.25
2	PSC24	18.25
3	PSS34	17.50
4	Consortia (all 3)	18.00

General View of the experimental site

PGPM capable of suppressing parasitic weeds

Extent of striga infestation

PSC7 (17.25%)

57% ↓

PSC24 ((18. 25%)

55% ↓

PSC34 (17. 5%)

Conosortium (All 4 16.67%)

Control (41%)

Biofertilizer and Biopesticides Technologies developed at The University of Agricultural Sciences

Biopesticides:

Local efficient strains of

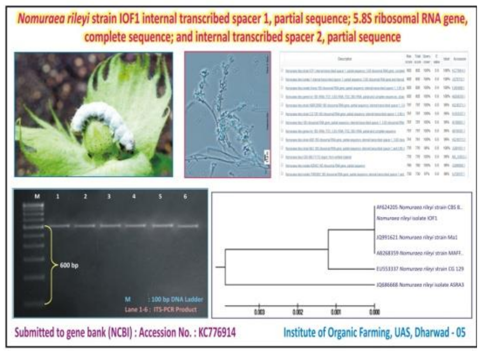
Fungal pathogens

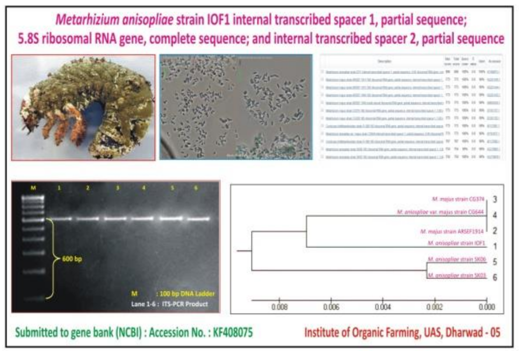
Beauveria,

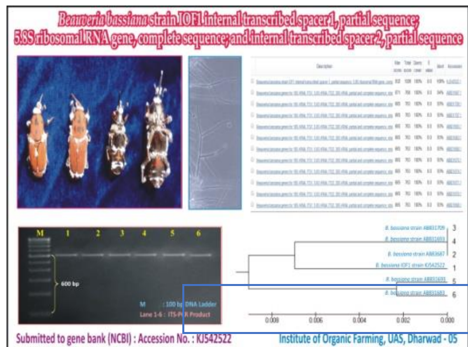
Metarhizium,

Verticillium

Nomuraea







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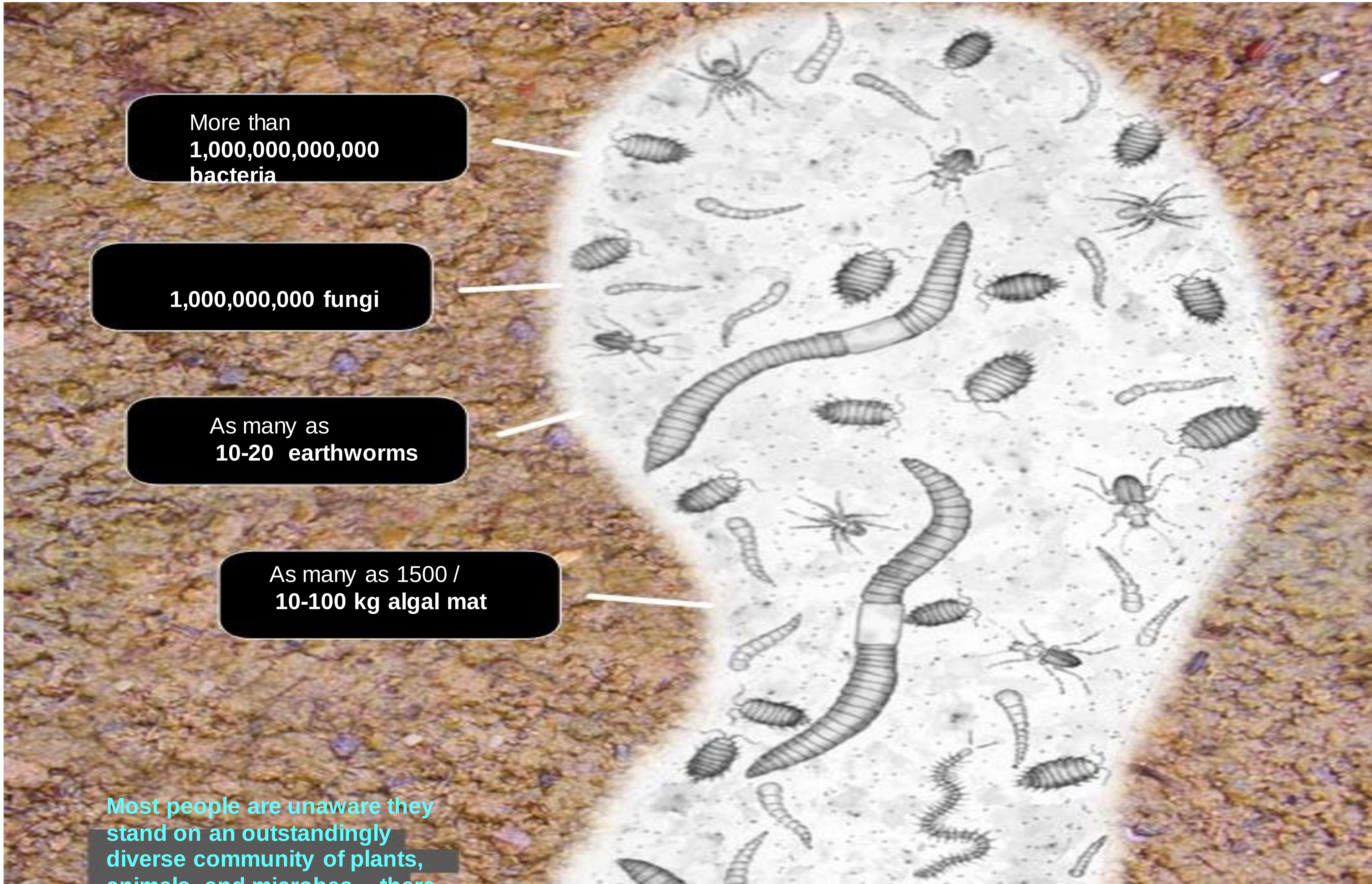
Gene bank (NCBI) Accession No: KM215209

THE NUMBER OF ORGANISMS IN A SPOONFUL OF SOIL IS MORE THAN THE WORLD'S HUMAN POPULATION

soil biodiversity and agriculture



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