Biofertilizers are seen as an important alternative technology, since the negative externalities of chemical fertilizers have become well known. The use of the latter has led to considerable environmental cost. Biofertilizers do not pollute the soil and do not disrupt the ecological balance, and hence are environment friendly. An increasing number of farmers are using biofertilizers, and the numbers of biofertilizer manufacturing units have also grown considerably. Organic farming system in India is not new and is being followed from ancient time. It is a method of farming system which primarily aimed at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (biofertilizers) to release nutrients to crops for increased sustainable production in an eco friendly pollution free environment. Organic farming has emerged as an important priority area globally in view of the growing demand for safe and healthy food and long term sustainability and concerns on environmental pollution associated with indiscriminate use of agrochemicals.

Going organic may be a clear way of getting back to basics and getting away from the havoc chemicals can wreak on our health and our environment but the basics themselves may not be so clear. This book provides the view of immense potential of biofertilizers as a supplementary nutrient source for the crops and covers all major types of bacterial fertilizers.

The major contents of this book is crop response to biofertilizers, nitrogen fixation, phosphate solubilising microorganisms, application and evaluation techniques, Bio Gas production, pest and disease management system in agriculture, production, promotion, quality control, marketing, future research planning, photographs and details of machineries, list of manufacturers and suppliers of biofertilizers and organic farming in directory section.

This book will be of use and interest to consultants, researchers, libraries, entrepreneurs, manufacturers of biofertilizer and for those who wants to venture in to this field.
Applications
Physiology of Organisms
Aerobes
Facultative anaerobes
Anaerobes
Symbionts
Agronomic Applications
Rhizobium
Azospirillum
Cyanobacteria
Cyanobacterial Associations
Photosynthetic Bacteria
New Associations
Industrial Applications
Chemical Catalysts
Ammonia Production
Hydrogen Production
Biomass Conversion
Timber Production
Phytochemical Production

3. NITROGEN FIXING MICRO-ORGANISMS: SYMBIOTIC
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Types of Biological Nitrogen Fixation
Factors Affecting Nitrogen Fixation
Genus: Rhizobium
Rhizobia
Rhizobium/legume Symbiosis
Methods for study of legume root nodulation
Isolation
Differentiation of Rhizobium from its common associate
Agrobacterium
Tests for nodulation
Infection test
Tissue and cell cultures
Acetylene reduction assays
Use of 15N to measure Biological Nitrogen Fixation
Multiplication of rhizobia: Root hair curling
Formation of infection threads
Nodule formation
Cross Inoculation Group
Fungicide Enhancement of Nitrogen Fixation
Stem Nodules
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Biofertiliser Role
Genus - Azolla
Introduction
Morphology and taxonomy
Role of Azolla
Inoculam Production of Azolla
Factors Affecting Successful Azolla Production
Azolla Nursery
Constraints
Conclusions and Future Outlook
Integrated Approach for Increasing Microbial Inputs
Economics of Biofertiliser Use

4. NITROGEN FIXING MICRO-ORGANISMS : ASYMBIOTIC
Genus : Azospirillum
Introduction
Taxonomy
Isolation, Maintenance and Cultivation
Physiology
Genus Azotobacter
Introduction
Distribution
Classification
Morphology and Taxonomy
Isolation
Crop Responses
Blue Green Algae
Introduction
Morphology
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5. PHOSPHATE SOLUBILIZING MICROORGANISMS : FUNGI AND BACTERIA
Problems in Phosphorus Uptake
Phosphate Fixation in Different Soils
Historical Developments
Phosphate Solubilization
Factors Affecting Phosphate Solubilization
Isolation
Mechanisms of Action
Role of acids
Other Mechanisms
Effect on Crop Yield

6. PHOSPHATE SOLUBILIZING MICRO-ORGANISM : MYCORRHIZAE
Comparision of Ectorophic and Vesicular-Arbuscular Mycorrhizae
Ectomycorrhizae
Systematics of Ectomycorrhizal Fungi and their Hosts
Morphology and Development of Ectomycorrhizae
Sources of Ectomycorrhizal Inoculum
Natural airbone spore inoculum
Soil already colonized by an EM fungus or fungi
The introduction of seedling with established mycorrhizae
The deliberate introduction of spores, sporocarps or sclerotia
Mycelial inoculum derived from pure cultures of known mycobionts
Evaluation and Selection of Ectomycorrhizal Fungi
Rapidity and extent of mycorrhization
Host response
Inorganic nutrient uptake
Water relations
Temperature tolerance
pH tolerance
Tolerance to soil toxicity
Stability of the partnership
Disease resistance
Strand formation
Ease of pure culture formation
Ease and rapidity of production
Edibility of the fruit bodies
Natural inoculum: airborne spores
Soil colonized by EM fungi
Seedlings colonized by EM fungi
Fungal sporomata or sclerotia
Mycelial inoculum
Endomycorrhizae (Vesicular-Arbuscular Mycorrhizae)
Systematics of Vesicular-Arbuscular Mycorrhizal Fungi and their Host
Morphology and Development of Vesicular-Arbuscular Mycorrhizae
Sources of VAM inoculum
Evaluation and Selection of VAM fungi
Laboratory experiments
Greenhouse crops
Field-sown crops
Prospects

7. APPLICATION AND EVALUATION TECHNIQUES
Different Methods for Biofertilizer Inoculation
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Top dressing of Biofertilizers
Granular biofertilizers:
Solarisation of FYM/Compost
Granular biofertilizer mixed with seed
Broadcasting of granular biofertilizers
Frequency of inoculation
Liquid inoculation of Biofertilizers
Methods of application of liquid inoculation
Drenching by Sprayers
Application in root zone
Culture pellet
Methods of Application of Other Biofertilizers
Blue Green Algae
Azolla
As green manuring
Azolla dual cropping
Azotobacter
Preparation and use of Azotobacter inoculant
Application
Azospirillum
Mycorrhizae
Endomycorrhizae
Ectomycorrhizae
Techniques for Isolation of Vesicular Arbuscular Mycorrhizal Fungi (VAMF) from soil in Laboratory:
Method for examination of mycorrhizal infection in root samples:
Foliar Biofertilizer
Humar
Humic Acid
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Foliar
Seed treatment
Soil Benefit
Root
Seeds
Plants
Precautions
Different Media Used to Study Biofertilizer
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   1. Yeast Extract Mannitol Agar
   2. Congo-red Medium
   3. Hofer’s Alkaline Medium
   4. Glucose peptone Agar
   5. Bergersen’s Synthetic Medium
Media for Testing Nodulating Ability of Rhizobium
II. Isolation of Frankia
   Media Used
III. Selective Media for Blue Green Alage
IV. Selective Media for Azotobacter
V. Selective Media for Azospirillum
VI Selective Media for Phosphate Solubilizing Organisms
VII Selective Medium for isolation of Pseudomonas fluorescens, a biocontrol agent
VIII Selective medium for isolation of Trichoderma an antagonistic fungus
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8. CROP RESPONSE TO BIOFERTILIZERS
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Dryland Legumes
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Azolla
Irrigated crop
Nonsymbiotic Nitrogen Fixation
Blue Green Algae (BGA)
Irrigated Crops
Azotobacter
Irrigated Crops
Dry land crops
Azospirillum
Irrigated Crops
Dryland Crops
Fodder Crops
Phosphate Solubilizers and Fixers
Mycorrhiza
Irrigated Crops
Dryland Crops
Fodder Crops
Phosphate Solubilizing Microorganisms
Irrigated Crops
Factors Affecting Crop Response to Biofertilizers
Interaction effect of microbial strains
Effect of nutrient interactions
Dryland Crops
Fodder Crops
Methods of Inoculation
Other Factors
Host Response to Biofertilizers
Interaction of Inoculants with other Nutrients
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9. SIMPLIFIED ANAEROBIC DIGESTERS FOR BIOFERTILIZER
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Plug Flow Digester Plant
Results
Covered Lagoon Biogas System
Results
Continuous Expansion Digester
Tests on a Small Electric Generator set Fuelled by Biogas
Results
An Economic Evaluation of the Plants
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10. MODIFIED ANAEROBIC FERMENTER FOR BIOFERTILIZER
Abstract
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Apparatus
Choice of a Laboratory Fermenter
The Proposed Impeller Design
Three-phase Fluidized Bed
Experimental Technique
Results and Discussions
Effect of using the 3-phase Fluidisation Technique
Effect of the Modified Paddle Mixer
Effect of Type and Duration of Mixing
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Conclusions and Recommendations

11. OPERATING CONDITIONS FOR ANAEROBIC DIGESTION OF BIOFERTILIZER
Abstract
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Design of the Experiment
Results and Discussion
1. Effect of the initial total solids (TS) concentration on
A. TVS reduction
B. Biogas and methane
2. Effect of hydraulic retention time (0) on
   A. TVS reduction
   B. Biogas and methane
3. Effect of temperature on:
   A. TVS reduction
   B. Biogas and methane
4. Effect of mode of operation on:
   A. TVS reduction
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12. BIOGAS PRODUCTION FROM ORGANIC BIOFERTILIZER
   Abstract
   Introduction
   Materials and Methods
   Organic Wastes
   Starter
   Digestion Apparatus
   Analytical procedures
   Experimental
   Results and Discussion
   Biogas Production from Geranium Flour (GF)
   Biogas Production from Akalona (AK)
   Biogas Production from Watermelon Residue (WR)

13. BIOGAS FROM LIQUID BIOFERTILIZER DERIVED FROM BANANA AND COFFEE PROCESSING
   Abstract
   Introduction
   Results

14. ORGANIC FARMING
   Pollution Problems with Fertilizers
   Water Pollution
   Atmospheric pollution
   Damage to crops and soils
   Heavy Metal Contamination
   Environment Restoration with Fertiliser
   Organic Matter
   Chemical nature of organic matter
   Organic Manures
   Organic residues
   Cow dung manure
   Live stock wastes
   Green Manure
   Importance of green manure
   Green manure crops
   Turning of green manure crops

  Biological contCONTENTS INTRODUCTION TO BIOFERTILIZERS Concept of IPNM Integrated Plant
Nutrient Management (IPNM) Biofertilizer Development Materials of Biological Origin Biofertilizers
Classification Potential of Biofertilizers in Crop Production in Indian Agriculture Chemically fixed Nitrogen
versus Biologically fixed Nitrogen Synergistic interaction between Biofertilizing Agents Biofertilizing agents
and Plant Disease Control Brief account of beneficial MicROORGANISMS RHizobium Azotobacter and
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Green Algae Plant Growth Promoting Rhizobacteria (PGPR) Status of Biofertilizer in India Thrust in Research
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17. PEST AND DISEASE MANAGEMENT SYSTEM IN AGRICULTURE Pesticide Usage Trend Harmful Effects

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Mechanical and physical control
Biological Control
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Release of Parasites
Use of Microbial Agents
Use of Predators
Cultivated crops
Varietal resistance
Pest Surveillance Methodology
Forecasting Pest Attack
Use of Selective Pesticide
Need-based Application of pesticides
Other pest Control Methods
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Role of government and private sectors in the promotion of IPDMS

18. BIOPESTICIDES
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Biological Control of Insect
Fungal Insecticides
Bacterial Insecticides
Bacillus thuringiensis (BT)
Mode of action
The question of resistance
Commercial Prospects
Improvements in BT through genetic engineering
The BT protein and the efforts on recombinant DNA in this area
Limitations of BT
Safety
Viral Insecticides
Nuclear Polyhedrosis Virus
Protozon Insecticides
Possibilities of field application
Botanical Pesticides
Pheamon trap
Trichocards
Biological control of plant diseases
Soilborne diseases
Methods for biocontrol
Biological Seed Treatment
Foliar Diseases
Introduction
Selection of biocontrol agents
Formulation and delivery system
Improved efficacy
Commercialization
Nematodes as Biological Control Agents
Production and Formulation
Biological Control of Nematodes
Biological Control of Weeds
Role of genetic engineering

19. SUSTAINABLE AGRICULTURE
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Crop Rotation
Biological Nitrogen Fixation
Mixed Cropping
Soil Micorbes on Crops
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Integrated Pest Management (IPM)
Sustainable Water Management
Post Harvest Technology
Extension Programmes
Sustainable Agriculture for India
Maintaining quality of the land resource
Indigenous Water Management
Conserving crop diversity
Stable farming systems
Judicious use of inputs
Role of biotechnology
Government support to farmers
Conclusion

20. PRODUCTION : PROMOTION : QUALITY CONTROL AND MARKETING
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High grade carrier
Suitable nutrient broth
Reliable packing material
Good quality of adhesive
Application of Updated Technology
Conventional method of production
Production of freeze dried culture
Improvement on technological procedures
Production System
Sterile carrier system
Improvement in sterilisation procedure
Fermentation technology
Latest Technology on Inoculant production
Bag and carrier
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Quality Control
Isolation and Identification of bacterial strains
Screening of the pure isolated strains
In Vitro
In vivo
Fermentation
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Raw material
Bacterial strain
Economic viability
Production process
Shelf life
Production Technology (Proposed)
Establishment of efficient Culture Bank
Research and Development (R & D)
Mass Production
Promotion
Field Experiments on R & D Farm
Trials on farms
Demonstration on Farmers’ Fields
Marketing
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Pricing policy and packing
Lack of awareness
Inadequate shelf-life
ISI Mark
Outlook

21. FUTURE RESEARCH PLANNINGS
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Soil Moisture and temperature
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Field Level
Method of Application
Marketing
Governments Future Planning for Promotion of Biofertilisers
Future

DIRECTORY SECTION
MANUFACTURERS OF BIO-FERTILISERS AND ORGANIC FARMING

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