



# Microbial processes in Agriculture

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**Abstract :** Agriculture bureaucracy a big portion of the economies of worldwide and consequently can make a contribution toward main continental priorities inclusive of eradicating poverty, starvation, fast industrialization, monetary diversification, sustainable aid, investments, and environmental control. Biotechnology is the hastily developing section and has different programs in sustainable agriculture. This chapter discusses the role of biotechnology, agroecology, and plant–microbial interaction for sustainable agriculture. For the growing international population, an in depth agricultural production is vital to fulfill meals requirements. Agricultural microbiology is offered as a synthetic studies discipline responsible for knowledge transfer from wellknown microbiology and microbial ecology to the agricultural biotechnology. A fundamental knowledge of the genetics, molecular biology, ecology, and evolution of symbiotic interactions should allow the development of microbe-based sustainable agriculture. Undoubtedly, getting biased rhizosphere opens new possibilities for future agricultural trends based totally on exploiting the beneficial microbial services to reduce the inputs of agrochemicals, thereby accomplishing sustainable environmental and within your means desires. The genetic sources of flora, animals, and microbes represent the uncooked fabric for all biotechnology-based studies, era improvement, innovation improvement, and introduction of latest merchandise. All the techniques of genetic assets, specifically collection, conservation, assessment, and utilization, have been eminently impacted with the aid of biotechnology. The molecular equipment of biotechnology have increased precision breeding by means of identifying, keeping apart, cloning, and switch of preferred genes from one species to another, rendering the idea of Mendelian population as an out of date concept. The detecting single-nucleotide polymorphism, figuring out functions of particular genes, assigning capabilities to unknown genes, and developing stepped forward transgenic with precise fruitful desired individual are the remaining desires of biotechnology. Agricultural practices are as of now applied on a global scale and numerous methodologies are being routed to meet sustainable environmental and reasonable trends, with the final aims of keeping yield even as safeguarding the biosphere. Therefore, the crossing factor of economic system surroundings (agroecology), environment society (environmental focus), and societyeconomy (life trendy) eventually determines the idea/movement of “sustainable development.”

## INTRODUCTION

A goal in sustainability is to discover out green methods for recycling nutrients, controlling pest and pathogens, and for lightening the bad impact of abiotic stress variables, critical problems for human existence, and for the sustainability of world ecosystems. So, the position and management of the foundation-associated microbiome is essential to fulfil each low cost and ecological sustainable troubles (Barea, 2015). Agricultural microbiology is added as a synthetic research subject answerable for the alternate of know-how from trendy microbiology and microbial ecology to the rural biotechnology. Analysis of the normal circulation of microorganisms among vegetation, animal, and soil-borne niches are required to reconstruct the arrangement of the microbiota in herbal and agricultural ecosystems. A transgenic plant is one which incorporates a gene or genes that have been brought artificially into the plant’s genetic make-up the usage of a set of several biotechnology techniques collectively known as recombinant DNA era. DNA spliced to the coding portion of the genes that serves to regulate how they characteristic is likewise transferred into the host plant. The inserted genes are called transgene while they’re inserted into the brand new host plant. The transgene might also come from some other plant of the equal or a one of a kind species, or a totally unrelated form of organisms like micro organism or animals. Some of the examples of genetically manipulated crops for global benefit are as follows: manage ripening improves shelf lifestyles and quality (e.G., tomatoes, peas, peppers, tropical culmination, broccoli, raspberries, and melons), insect resistance to reduce insecticide use (e.G., tomatoes, potatoes, corn, rice, lettuce, coffee, cabbage own family, and apples), fungal resistance to lessen fungicide use (e.G., peppers, tomatoes, and cucumbers), viral resistance reduces sicknesses prompted by means of plant viruses and, seeing that insects carry viruses, reduces use of pesticides (e.G., potatoes, tomatoes, cantaloupe, squash, cucumbers, corn, oilseed rape canola, soybeans, and grapes), and herbicide tolerance improves weed manipulate (e.G., soybeans, tomatoes, corn, cotton, oilseed rape canola, and wheat).

Microbial biotechnology contributes to sustainable agriculture via lowering the dependence on agrochemicals, especially pesticides, through the deployment of genes conferring tolerance or resistance to biotic and abiotic stresses. Carefully selected genes from associated or unrelated genetic resources are included in otherwise suitable genotypes. It is a popular opinion that the most promising approach to attain this purpose is to replacement unsafe use of mineral fertilizers, pesticides in agriculture with environment-pleasant symbiotic microbes, that could improve the nutrition of vegetation, in addition to their safety towards biotic (pathogens and pests) and abiotic (including pollutants and climatic trade) demanding situations. Agriculture encompasses the whole lot of the machine that grows, and affords meals, feed, fiber, ornamentals, and biofuel for the state. Agriculture includes the management of natural assets, for instance, surface water and groundwater, forests and other lands for business or leisure makes use of, and natural

world; the social, physical, and biological environments; and the general public policy issues that relate to the overall device. All sports, practices, and methods of standard society and personal sectors are involved in agriculture and forestry.

Examples of practices designed to improve environmental execution of traditional agriculture are as follows:

1. Crop rotation
2. Cover crops
3. Reduced-tillage and no-till practices
4. Integrated pest management
5. Precision farming
6. Diversification of farm establishments
7. Other agricultural conservation exceptional management practices

The improvement of plants and animals which have advanced genetic resistance to climatic extremes, pests, and different threats, often with the utilization of new GE equipment. Some farming methods were developed, at the least in element, to reply to perceived issues associated with traditional farming. Such processes emphasize the utilization of natural methods within the farming machine, frequently called “ecological” or “surroundings” techniques, which fabricate productivity (and preferably resilience) through complementarities and cooperative energies within the area, the farm, and at larger scales across the panorama and community. Examples of ecologically primarily based farming systems are as follows:

1. Organic farming structures
2. Biodynamic farming systems

In its broadest sense, sustainability has been defined as the capacity to offer for middle societal wishes in a way that may be easily continued into the indefinite future without unwanted terrible effects. The sustainability of a farming practice or gadget might be evaluated on the idea of ways nicely it meets numerous societal goals or targets.

1. Satisfy human meals, feed, and fiber wishes, and make a contribution to biofuel needs.
2. Enhance environmental best and the resource base.
3. Sustain the financial viability of agriculture.
4. Enhance the exceptional of life for farmers, farm workers, and society as a whole.

#### Plant Microbe Interaction:

Microorganisms can affect agricultural productivity, for instance, by means of helping and controlling nutrient availability/acquisition and selling strain tolerance. The richness of species and variety of microbial groups that comprise the plant microbiome, as well as the elements affecting it and their performance, are normally unknown. The importance of this difficulty is evidenced via the growing number of clinical courses in this subject matter in current years, in addition to studies that specialize in specific niches of plant life and how they modulate their specific microbial groups. It is essential for a higher know-how of the most important drivers of the composition of plant microbiome, which is an lively issue of the host, additionally aware of modifications in environmental (biotic and abiotic) conditions. In order to recognize the elements that influence this assembly and the dynamics from a phylogenetic and functional perspective, latest studies have centered on numerous elements of the plant microbiome one after the other. Partitioning the plant microbiome considers three noteworthy compartments where microbial cells can set up and develop: the so-known as rhizosphere, endosphere, and phyllosphere (Hirsch, Miller, & Dennis, 2013). In spite of the reality that the plant microbiome is perceived as a amazing fortune trove of microbial variety, diverse critical crop species and their natural household have no longer but been studied for his or her associated bacterial groups. To higher apprehend the importance of the plant-associated microbiome within the prevention of pathogen, outbreaks were suggested (Andreote, Rocha, Araujo, Azevedo, & Overbeek, 2010). The loss of suitable technique has confined advances for a complete know-how of the mechanisms underlying plant microbe interactions in the rhizosphere. Challenges depend mostly on the need of profiling an awesome cluster of procedures where the enormous and one-of-a-kind microbial groups are predominantly constituted by uncultivable microorganisms (Carvalhais, Dennis, Tyson, & Schenk, 2013).

These strategies, based totally on molecular approaches, are likewise predominant to assess the consequences of bothers incited by means of biotic and abiotic stress factors on soil microbiome variety and on plant microbe interactions, in the gift state of affairs of worldwide alternate. Improving the capacity of soil microbes for strain remedy in crops is based on a better knowledge of plant microbiome interactions (Barea, 2015). Diverse types of strain factors, which includes salinity, drought, nutrient deficits, infection, illnesses and pests, etc., can modify plant microbe interactions inside the rhizosphere. Scientist discovered that the presence of even small quantity of water can have an effect on the structure of plant roots in soil, a finding that opens up new opportunities to enhance water and nutrient getting older for important food crops. The diploma of root branching determines the efficiency of water uptake and acquisition of vitamins in crops. Understanding the regulation of root branching is therefore of crucial significance. Recently, Bashan, de-Bashan, Prabhu, and Hernandez (2014) accept appear a absolute analysis on the conception and applied perspectives of inoculants technology for PGPR. They acclaim a cardinal of top priorities of analysis to apparatus commitment systems for PGPR and rhizobia. For the acknowledged appliance of microbial inoculants in agriculture, the afterward aspects charge to be implemented: (1) to access the scientific/technological bases of inoculums assembly and application; (2) to accomplish specific normative for anniversary inoculants blazon and its application, either on the seeds or on the soil, or to the bulb to be crude already microbized; (3) to set up quality-control protocols; (4) to abbreviate the aberration of the acreage results; and (5) to aggrandize advice and breakdown by answer advantages and limitations, and allowances for society.

Seed is a basal and axiological claim for acceptable advance in agronomical productivity, as 90% of the aliment crops are broadcast from seed. The seed-borne, aboriginal division diseases and insects aftermath adverse aftereffect if not handled timely. Emphasis on abreast agronomics is to aftermath added with bottom land, water, and manpower. The age-old environment-friendly ache administration practices like sanitation, crop rotation, alloyed cropping, acclimation of date of sowing, fallowing, summer ploughing, blooming manuring composting, etc. to action bulb bacilli accept already absent their acceptability and are actuality reevaluated as a basic of chip annoyance management. Undoubtedly, accepting biased rhizosphere opens new opportunities for approaching agronomical developments based on base the benign microbial casework to abatement the inputs of agrochemicals forth these curve accomplishing acceptable ecology and economical goals.

1. Harnessing the rhizosphere microbial communities through agronomical managements.
2. Learning how plants appearance microbial association anatomy in the rhizosphere.

3. The “biased rhizosphere” concept/action. Several methodologies are at present baffled to actuate whether the rhizosphere can be engineered (biased) to empower benign organisms, while preventing attendance of pathogens.

The cold analysis capacity action abounding difficulties on the area that there are abounding crevices in our understanding. Altitude change is one of the above all-around problems, affecting the action on the planet Earth. Altitude change usually affects the photosynthesis (carbon assimilation), basis activity, accepted morphology, and activity of the bulb specimens as able-bodied as their interactions. Increasing atmospheric carbon dioxide (CO<sub>2</sub>) reduces crop nitrogen content, which may arrest abounding pests and diseases and thereby causes change in the agreement of edger flora that accompanies the crops. Due to boundless and injudicial use of actinic fertilizers, agronomics faces assorted challenges (Bhattacharyya, Sarmah, Dutta, & Tanti, 2015). Synthetic fertilizers are accepted to clean out a ample allotment of soil’s artlessly occurring capital micro- and macronutrients. Change in ecology altitude due to altitude alterations is acceptable to abet changes in bulb analysis and basis exudation. The analysis is capital to advance the ability on built-in biodiversity and microbial association structure, beneath changing-climate scenario. Biofertilizers are the microbial inoculants which can be usually authentic as a alertness absolute alive or abeyant beef of able strains of nitrogen fixing, phosphate solubilizing, and cellulytic microorganisms, etc. In adverse to actinic fertilizers, biofertilizers are applicable microorganisms which are not the antecedent of nutrients but accommodate advice to plants in accessing the comestible availability in rhizospheric region. Several microorganisms are frequently acclimated as biofertilizers including nitrogen-fixing clay bacilli (Azotobacter, Rhizobium), nitrogen-fixing cyanobacteria (Anabaena), phosphatesolubilizing bacilli (Pseudomonas sp.), and AM fungi. Similarly, phytohormone (auxin)-producing bacilli and cellulolytic microorganisms are additionally acclimated as biofertilizer formulation. These microbial formulations are acclimated to enhance assertive microbial action to access the availability of nutrients in a anatomy which can be alloyed by plant.

Biofertilizers are low-cost, renewable sources of bulb nutrients. These are the strains of benign adobe microorganisms which are able and arranged in acceptable carrier in laboratory. A carrier is a material, such as peat, lignite powder, vermiculite, clay, talc, rice bran, seed, charcoal, soil, bedrock phosphate pellet, paddy harbinger compost, wheat. bran, or a admixture of such materials, etc. which provides bigger shelf activity to biofertilizer formulation. Recently, biofertilizers are accepting drive due to the all-inclusive advantages such as aliment of adobe bloom and abridgement of ecology abuse by appliance of the chemicals in agronomics (Muraleedharan, Seshadri, & Perumal, 2010). Increased crop crop abundantly depends on the blazon of fertilizers acclimated to access capital nutrients for bulb advance and development. For optimal bulb growth, it requires nutrients in acceptable and counterbalanced quantities but from the adobe alone a baby allocation of nutrients are appear every year through biological or actinic processes. Therefore, aim of fertilizers use is to supplement the nutrients already abide in the soil. Besides comestible supplementation, biofertilizers accept assorted added allowances for archetype ascendancy soil-borne diseases, improves adobe health, adobe backdrop and aftereffect in college crop rates. At present, a array of bartering biofertilizer formulations are available, and assorted strategies accept been adopted to accomplish abiding best activity of the microorganisms acclimated in such formulations.

The strategies comprise

- (1) access of biofertilizer formulation
- (2) appliance of aqueous biofertilizer
- (3) appliance of thermotolerant/ drought-tolerant/genetically adapted strains.

Several microorganisms and their affiliation with crop plants are actuality exploited in the assembly of biofertilizers. They can be aggregate in altered means based on their attributes and action. Mycorrhiza is a acclaimed affiliation of bane with the roots of college plants. Although it charcoal mystery, it serves as an archetypal arrangement to accept the accoutrement abaft dispatch of advance in the basis beef as an aftereffect of mycorrhizal inhabitation. Bioactive ligands alleged Myc factors and Nod factors buried by mycorrhiza and rhizobium were perceived by host roots to activate the arresting transduction pathway, which initiates added arresting transduction alleyway through alien receptors (SYM<sub>1</sub> and NORK) which activate absolution of Ca<sup>2+</sup> in the cytosol. The accomplished alleyway involves receptor like kinases or added kinase-related proteins like DMI and SYM<sub>71</sub> to phosphorylate their substrates. Nuclear pore circuitous and some of its proteins (NUP) comedy a role in calcium spiking. DM<sub>1</sub> proteins comedy a role in advancement alternate cadence of calcium ions central and alfresco the nucleus. Several approach proteins (Ca<sup>2+</sup> approach proteins) additionally facilitate this action with the advice of assorted transporters. C<sub>Ca</sub>MK is a calcium calmodulin-dependent protein kinase, which phosphorylate the artefact of CYCLOPS protein appropriately initiating activation of assorted genes involving accumulation of structures like birthmark and prepenetration apparatus. Biotechnology could as able-bodied disregard in developing another controls to constructed insecticides to action adjoin insect pests. Formulas for coatings these benign bacilli could be developed to assure the bulb during the analytical bulb stage. Continually, buzz biopesticides are bacterial and fungal agents such as *Trichoderma* spp., *Ampelomyces quisqualis* (a ascendancy abettor for grape arenaceous mildew), and *Bacillus subtilis* (used to ascendancy bulb pathogens). Agile acreage reckons a bacillus that acts as a biocontrol agent, anon affecting the antibody (e.g., Contans), or produces an admixture during beverage that provides control. Biotechnology offers abundant opportunities to access all-around agronomical assembly and strategies to assure our ambiance through bargain use of agrochemicals like pesticides, fertilizers, rodenticides, etc.

Biotechnology has played a cardinal role against the accomplishment of ecology sustainability by appliance ecofriendly crops such as herbicide tolerant, insect-resistant breed and crops that can fix atmospheric nitrogen arch to ablation of the environment. The acceptance of these atypical technologies such as biotechnology in aliment security, ecology sustainability, and bread-and-butter development was accustomed at the United Nations Accepted Assembly in 2005 (Ene-Obong, 2007).

Probiotics are alleged applicable microbial comestible supplements that, back alien in able quantities, beneficially affect beastly actuality through their furnishings in the abdominal amplitude (Holzapfel & Schillinger, 2002). The appellation “probiotic” agency “for life,” and it was declared by an able board as “live microorganisms which aloft assimilation in assertive numbers apply bloom allowances aloft inherent accepted nutrition” (FAO/WHO, 2001). Probiotics accept been acclimated back several years in brewed dairy products. However, the accessible uses of probiotics in nondairy aliment articles and agronomics accept not accustomed academic attention. A alloy of probiotic bacilli with nutrient-dense foods, for archetype dairy products, will accept the absolute account in acceptable customer nutrition. In present scenario, there has been an added absorption to aliment and agronomical applications of probiotics, the alternative of new probiotic strains, and the development of new appliance has acquired abundant importance. Probiotics accept become a actual important comestible agency to circadian bloom aliment products, and their common bazaar is estimated aloft US\$28.8 billion by 2015. The agronomical applications of probiotics in animal, fish, and plants assembly

accepted day by day. The nonpathogenic bacilli acclimated as probiotics abide of a advanced array of microbial strains and accept adeptness to adhere, colonize, and attune the beastly gastrointestinal tract. Lactobacillus and Bifidobacterium are the above probiotic groups but there are some microbial strains such as Pediococcus, Lactococcus, Bacillus, and yeasts. which are additionally appear with probiotic potential. Some of the articular probiotic strains display able antiallergic, antiinflammatory, and added important properties.

GE is additionally alleged abiogenetic modifications, which deliberates assertive characteristics of an animal by manipulating the abiogenetic actual of accurate plant. GE is additionally differing from accepted methods of abiogenetic modification in two absorbing ways:

- (1) acquaint one or a few well-characterized genes into bulb and
- (2) acquaint genes from any breed into a plant. Number of crops developed on the base of abiogenetic abetment strategies to affected the aliment accident and accommodate aliment with acceptable diet to world.

The examples are as follows:

1. Insect-resistant crops [Bacillus thuringiensis (Bt cotton)]
  2. Herbicide-tolerant crops
  3. Viral-resistant crops
- Biodiversity refers to all breed of plants, animals, and microorganisms absolute and interacting aural the ecosystem. Natural biodiversity has provided the foundation for all agronomical plants and animals. Biological base of agronomics can be sustained, but this will crave both managing the agroecosystem and alteration the biological players.

In ablaze of this, we focus on three key areas which accommodate

- (1) managing bulb rhizosphere processes
- (2) the abeyant and limitations for modifying these processes
- (3) the contributions and banned of biotechnology in convalescent abundance from transgenic plants. Sustainable crop assembly will crave accession and aliment of clay amoebic amount (SOM), accumulation of water-stable clay aggregates, added microbial transformation of nutrients in the rhizosphere, alternative of locally acclimatized crop and microbial ecotypes, and bigger attrition of crops to pests and disease. Thus, two key areas of analysis accommodate the ecological administration of rhizosphere processes, abnormally the interactions amid microorganisms and bulb roots and added genotype-environment analogous with crops through the use of built-in abiogenetic assets and alert appliance of biotechnology. Long-time adherence and crop can be accomplished through acceptable administration by alien inputs; they are as follows: 1. Adobe fertility: It is one of the best important inputs for the accurate crop. Adobe represents a awful amalgamate ambiance for the microbiota inhabiting it; the altered abstracts of the solid fractions in adobe (sand, silt, clay, and amoebic matter) accommodate myriads to altered aboriginal microbes. Microorganisms collectively are the basal catalysts of the biochemical processes in soil. These processes are affected to above changes in the surroundings, whereby a assessable aftereffect will be the aftereffect of alone accouterment at the micrometer scale.

SOM and adobe particles authority ample food of bulb nutrients. Crop roots and residues advance adobe abundance by aesthetic soil-microbial communities and convalescent adobe aggregation. This bigger adobe concrete ambiance aids baptize infiltration, baptize holding, aeration and, ultimately, basis growth, and bulb nutrient. 2. Adobe amoebic amount (SOM): This is distinctively the added labile components, plays the key role in advancement adobe abundance and anatomy in abounding soils. SOM is chemically heterogeneous, abnormally consisting of sloughed-off basis cells, asleep roots, exudates from active roots, microbial and bearcat biomass, fungal hyphae, mucilages and polysaccharides, amid added components. The added labile components, abnormally aural the rhizoplane (on or abutting to the apparent of roots), serve as a accessible antecedent of energy-rich carbon compounds all-important to abutment aerial levels of microbial activity. 3. Adobe biology: Microbial basin action contributes to bulb diet through decomposition, ammonification, nitrogen fixation, and solubilizing phosphorus. Together with mucilages and polysaccharides from roots and bacilli and the arrangement of fungal hyphae, SOM is capital to the accumulation of water-stable aggregates, the axiological architecture blocks of adobe structure. 4. Rhizosphere management: Bulb roots alive in abutting affiliation with assorted microbial communities selectively recruited from adobe via rootexuded carbon: adverse biota recruited by crop bulb rhizospheres account cogent anniversary all-around losses. In the developing countries, decidedly in India, the basal botheration of assembly is rural abjection and hunger. The agroecology could be acclimated to boldness the citizenry ache botheration via absorption on a arrangement that may change baby crop adaptation angled agronomics to a ample yield, profitable, and awful acceptable agriculture. It is one of the best accomplished means to enhance crop abundance application agroecology in altered agroecosystems, which allows allowances to the additional crop through the aboriginal crop via alteration the ecology altitude for additional crop (Tripathi, 2015).

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