Sub-project 4

Development of agro-ecological zone specific microbial blue prints for implications in sustainable agriculture

Lead Centre: NBAIM, Mau

Background

Sustainable agriculture is a worldwide key word for agriculture in which microbial communities associated with the plants and within the soils have a major decisive and identified role to play. Microbes are the most live, vital and important communities to affect plant and soil health and crop wellbeing along with the sustenance of the ecological niches. Microorganisms are important to take into account for sustainable agriculture because they really define the quality and productivity of the soils in a given agro-ecosystem. Microbial diversity, microbial load, presence of indicator microorganisms and their useful functions are definitive indexes to study soil and plant health. Environmental stresses, biotic pressures and agricultural interventions in different agro-ecological zones is posing a dramatic shift in microbial diversity and the structural change of microbial communities that further leads to change the functional activities. In the rhizosphere, microbial communities are capable to alleviate abiotic (salinity or drought) or biotic stresses in plants by different mechanisms thereby, creating a greater opportunities to study the real-time interconnections within inter- and intra-species cross-talk and its impact on biodiversity.

Microorganisms are the ubiquitous janitors of the Earth, occurring in all climate areas, including those once considered to be most unlikely to support life—the cold of the Arctic and Antarctic, the heat of geysers and oceanic hot vents, and deep within rocks. They are decomposers, converting nutrients in organic wastes and from dead organisms into molecules that are reused within ecosystems. Microorganisms also include agents that cause disease, in some cases, maintaining ecological balance, in others, decimating host populations. The term biodiversity is related to the number of species or species richness associated with the richness of activity each species undergoes during its existence through events in the life of its members along with the nonphenotypic expression of its genome. Thus, to study microbial biodiversity, it is necessary to understand interactions between and among species in a given habitat. How these species are grouped as a living unit in a given ecological niche is a task that is heroically difficult to complete for microorganisms, without a massive, globally coordinated program of action and this why this challenging and enthusiastic task of uncovering microbial communities and their functional attributes in connection with their use in agro-ecology specific and non-specific agriculture is being undertaken.

India is gifted with heterogeneous landforms and variety of agro-climatic conditions such as the lofty mountains, the raverine deltas, high altitude forests, peninsular plateaus, variety of geological formations endowed with temperature varying from arctic cold to

equatorial hot and rainfall from extreme aridity to perhumid with world's maximum rainfall. This provides macro relief of high plateau, open valleys, rolling upland, plains, swampy low lands and barren deserts. These varying environmental situations in the country have resulted in a greater variety of soils, plants and of course, their associated microbial biota. Therefore, a systematic appraisal of different agro-ecological regions with special reference to the microbial communities inhabiting their soils and plants has tremendous scope in grouping relatively homogenous regions in terms of soil, climate and physiography with the microbiological typing. It is therefore, imperative to identify the potentials of formulating crop/cropping systems within different agro-ecological regions with soil physical conditions, nutrient availability, organic carbon pool and microbial blue-printing.

Rationales

Microbial diversity is fundamental to maintenance and conservation of global genetic resources.Microbial communities in different agro-ecological regions have tremendous potentials as they have developed and deployed many mechanisms for their growth and development and helped floral biota to sustain in these regions. However, lesser attention has been paid to explore diversity of microbes in different agro-ecological environments.

Microbiome plays an essential role in the maintenance of soil health in different regions but only limited knowledge is existing concerning to their genetic diversity. Microbial biodiversity of different agro-ecological regions of India is still unexplored, though few fragmented approaches in selected areas like Western Ghats, NE regions etc. have been made but a holistic approach to explore the microbial biodiversity of different regions is a need of hour. So, to fulfill the Indian standing with global microbial biodiversity initiative, this project has specially been formulated keeping in view the microbial diversity lying in association with the crop plants and their rhizosphere in different agro-ecological zones of India.

Project will focus on structural & functional diversity of plant & rhizospheric soil associated microbial communities present in different agro-ecological zones of India & characterization of their functionalities for implications in sustainable agriculture.

In each agro-ecological zone microbial diversity will be assessed from major crop plants (epiphytic & endophytic) & their rhizospheric soils in different representative locations. Taxonomic as well as polyphasic along with culturable & metagenomics approaches will be followed to establish community level microbial blue print of the different agro-ecological zones. Varied types of microbes (bacteria, actinomycetes, methylotrophs, cyanobacteria & fungi) isolated, identified & characterized from different zones along with their agriculturally important functions will strengthen microbial genetic resources at NBAIM. Unculturable community profiling based on different functional genes will help to establish the role of different microbial communities associated with the plants & their rhizosphere soils. Year wise & crop wise comparative analysis of microbial communities will led to the spatial & temporal biodiversity of existing microbial communities, that when coupled with the edaphic conditions, can predict the impact of changing climatic scenario on the variability of microbial communities.

The project will involve four partners working in the microbiological domain in ICAR/Universities who will be responsible for the microbial community profiling of selected agro-ecological zones assigned to them.

Objectives

- ✓ Preparation of a blue-print of plant associated microbial biodiversity of different crops, crop-combinations in different agroecological regions/zones
- ✓ Development of the base line information on zone specific microbial biodiversity
- ✓ Functional characterization of trait-specific microbial communities in different cropping patterns
- ✓ Screening and evaluation of microbial isolates for potential applications in agriculture
- ✓ Conservation and documentation of microbial bioresoureces for future needs

Major activities

- ✓ Survey and sampling from different agro-ecological zone
  a) Survey and sampling of selected sites of different agro-ecological zones of India
  b) Isolation and characterization of potential microbial species
- ✓ Structural blue-print of microbial communities

  Microbial population present in the zone will be analyzed by using culture dependent and culture independent (metagenomics) approach

- ✓ Development of the base line information

  A detailed description of zone-wise microbial germplasm will be developed from agro-ecological regions for comprehensive microbial mapping and comparative assessment based on structural diversity

- ✓ Assigning functional attributes to microbial species/communities

  Functional attributes to the microbial species/communities will be assigned to explore the essential nature and role of microbes and/or their products in sustaining agricultural practices in different zones.

- ✓ Conservation, documentation and utilization of microbial bio-resources

  Short term and long term preservation of microbial germplasm will be done for biodiversity conservation and future utilization

- ✓ Screening of isolates for potential application in agriculture

  Microbial germplasms will be screened for its agricultural applicability

✓ Data analysis

Data will be compiled and statistical analysis will be done

Work plan of activities (Yearwise)

ACTIVITIES	I year	II year	III year	IV year
Survey and sampling from different agro-ecological zone				
Structural blue-print of microbial communities				
Development of base line information on zone specific microbial biodiversity				
Assigning functional attributes to microbial species/communities				
Conservation, documentation and utilization of microbial bioresoureces for future agriculture				
Screening of selected isolates for their potential application in agriculture				
Data analysis				