# Soil Enzymes and Microorganism: Their Relationship and Role in Sustainable Farming

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**Abstract:**

***Soil enzymes are the important activators of various life processes and plays a vital role in maintaining soil health and ecosystems. The soil enzymes are mostly dependent upon the microorganism which are either derived extra cellularly or intracellularly. They are the important parameters for determination of soil physical, chemical and biological activities. There are various soil enzymes which depends upon various factors such as on pH, location, type of soils, cropping systems etc. for functioning. Healthy soil is an integral part of ecosystem which helps the ecosystem to remain intact from various disturbances created by several challenges such as changes in climatic condition, infestation of pest and diseases, exploitation of lands due to agriculture and drought. As soil is an important part of ecosystem for sustaining life of various organism, the protection of soil is indeed a need of an hour from various exploitation. Also the soil enzymes being the active part for maintaining soil health a better understanding in its role and discovery of new enzymes will provide a good opportunity for integrated biological assessment in several soil and also helps to measure the changes of different soil enzymes with change in soil and crop management practices. Therefore, it becomes very necessary to understand the enzymatic activity and role in maintaining better soil health.***

**Keywords:** Enzymatic activities, Microorganism, Soil enzymes, Soil health.

## Introduction:

Soil is the "Source of Infinite Life". Based on biological, physical and chemical attributes, soil can support crop growth and development. This inherent feature of soil is known as soil productivity. All natural activities in the soil are necessary for the growth of grasses, crops, plants, forests, and human and animal life. Unfortunately, recent human activities like deforestation and desertification have affected biodiversity, resulting in changes in the soil matrix and reducing soil productivity. Besides this now-a-days farmers are applying various kinds of harmful chemical fertilizers and pesticides for better yields and pest management purposes. These chemicals are leaving highly detrimental and irreversible effects not only on the soil properties, health of human and animals but also on the ground water and water consumed by humans due to contaminated soil (Singer and Ewing, 2000). The residual toxicity of those chemicals has created lots of serious health issues among humans and animals and has affected the beneficial microorganism residing in the soil, which are directly or indirectly related in managing healthy environmental conditions. Soil is a natural source of various microorganisms that may be pathogenic towards plants or beneficial for sustainable crop growth. The management of soil physical or structural properties is directly related to the enzymatic activities that favor various bacterial, fungal and actinomycetes populations to grow and degrade crop residues. These microorganisms and soil enzymes are closely related to each other and help sustain all biochemical, biological and physical processes within the soil. These soil enzymes play a vital role in decomposing process of organic carbons (Sinsabaugh *et al*., 1991) and acts as an important catalyzing agent of various biochemical reaction that helps in sustaining life process of microorganism in soil thereby increasing the soil properties (Dick *et al.*, 1994; Dick, 1997). Ever-increasing pollution in crop field due to excessive use of chemical fertilizers and pesticides makes it necessary to initiate a new trend of applying biological control using the beneficial microorganisms and soil enzymes correlation for sustainable crop growth.

## Soil Enzymes:

The soil enzymes are the biochemical compound that is present in the soil. They play a vital role in various biological and physio-chemical processes like nutrient cycle such as Carbon, Nitrogen, Sulfur, and Phosphorus cycle and organic matter recycling by decomposing of soil organic matter and also

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helps in other vital reactions in soil microclimate (Rao *et al.*, 2017). Besides microorganisms, animals and human beings also contribute to the pool of soil enzymes. Various soil management operations have a massive effect on enzymatic activity in the soil and help determine soil health conditions by maintaining a good soil enzyme profile. Proper knowledge of the beneficial role and impact of soil enzymes may help in guiding us to grow our crop plant sustainably.

**Types of Soil Enzymes:**There are different types of soil enzymes present in the soil and have different function. Itcan be classified based on:

i. Amount present in soil
ii. Location
iii. pH Optima
iv. Participation of chemical reactions

**Amount present in the soil:** Based on the quantity of enzymes present in the soil, enzymes can be either Inducible or Constitutive enzymes.

**Inducible enzymes:**Those enzymes which are present in the soil in very minute quantity and changes its concentration depending upon the presence or absence of substrate. Its quantity can rise abruptly with the availability of the more substrate.

Ex: Amidase

**Constitutive enzyme:** Those enzymes which arepresent in high amount in a cell its amount does not depend on the presence of substrate. Ex: Pyro-phosphatase.

**Location:**

**Extracellular:** These enzymes are present in the soil and get attached to the humus or clay particles in immobilized form through covalent bond, hydrogen bond, or ionic interaction.

**Intracellular:**These types of enzymes are present in living or metabolically active cell inside the cell wall or cytoplasm(Rao *et al.*, 2017).They are released only after the death of the cells.

**pH Optima:** There are many enzymes that depends upon the reaction of the soil pH.

**Acidic pH:**Those enzymes which are available at pH 3.0 are Arylsulphatase, Cellobiohydrolase (pH 4.0-4.5) and β-xylanase (pH 4.5-5.5).

**Acidic to Sub acidic pH:**Examples of enzymes available at acidic to sub acidic pH are β-glucosidase (pH 3.0-4.75), β-N-acetylglucosaminidase (pH 3.0-5.0), α-glucosidase (pH 3.0-7.0)

**Acidic to Alkalie pH:**Examples of enzymes available at acidic to alkali pH are Acid phosphomonoesterase (pH 3.0-5.0), Phosphodiesterase (pH 3.0-5.5), Alkaline phosphomonoesterase (pH 9.5-11.5).

**Participation of chemical reactions:** These enzymes participate in the chemical reaction in the soil and help maintain a quality soil profile. Some examples are listed below.

**Ligases:** These enzymes form the bond by cleavage of ATP. Ex. Acetyl-CoA carboxylase.

**Isomerases:** Take part in isomerization reaction.

**Oxidoreductases:** Take part in oxidation and reduction reaction. Ex. Peroxidase, Catalase, Dehydrogenase.

**Hydrolases:** Break the hydrolytic bonds. Ex. Phosphatase, Urease, Cellulase.

**Transferases:** Transfer atoms to acceptor molecules from a donor. Ex. Rhodonase, Aminotransferases.

**Source of soil enzymes:**

The soil enzyme is an important indicator of soil health. Soil enzymes are mostly contributed byliving and dead microbes, many plants and their residue and roots, soil flora and human being, soil animals which helps to maintain pool of soil enzymes and to increase its concentration.

**Table 1. Lists of important soil enzymes and their sources.**

| Sl. No | Soil enzymes | Source |
|---|---|---|
| 1. | α-Amylase | Plants, Animals, Microbes |
| 2. | β-Amylase | Mostly Plants |
| 3. | Dehydrogenase | Microbes |
| 4. | Endo-1,4-β- glucanase | Termites, Protozoa, Microbes |
| 5. | Phenol oxidase | Plants and Microbes |
| 6. | Urease | Plants, Invertebrates, Microbes |
| 7. | Alkaline Phosphatase | Bacteria |
| 8. | Acid Phosphatase | Fungi, Bacteria and Plants |
| 9. | Arylsulphatase | Animals, Plants, Microbes |
| 10. | Protease | Plants, Microbes |
| 11. | Chitinase | Plants, Microbes |

**Functional activities of soil enzymes in soil:**

We all know that every enzyme has its specific substrate and on substrate, there is an active site on which enzymes bind and form a temporary enzyme-substrate complex. After an enzymatic reaction, some products are released, which contribute to the nutrient pool of the soil to enrich plant growth. The majority of the enzymes accumulate in soil matrix forming complexes with clay or soil organic matter. These stabilized enzymes contribute more to the soil reactions than the enzymes that remain in the microbes' viable cells. Only dehydrogenase enzymes show its activity more in viable cells. Soil enzymatic activity is a valuable indication of soil productivity, the reaction rate of various soil processes, activity of microbes and negative effects of various pollutants with in the soil matrix (Nare *et al.*, 2014).

**General functions of some soil enzymes are:**

1. Decomposition of soil organic matter,
2. Nutrient recycling
3. Energy transfer
4. Catalyze many important reactions in soil
5. Stabilize the soil structure
6. Indicator of minute changes in soil environment and soil management practices

(Rao *et al.*, 2017)

**Functions of some specific soil enzymes are as follows:**

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**β-glucosidase:** It catalyzes the cellobiose hydrolysis reaction and end product of β-glucosidase mediated reaction is glucose. This enzyme helps in transfer of energy for microorganism. It indicates the rate of soil organic matter decomposition.

**Urease and Amidase:** It catalyzes urea hydrolysis and end products are Carbon-di-oxide and Ammonia ($NH_3$).This enzyme makes the nitrogen available to the plants in $NH_4$ form. It is an important parameter of Nitrogen recycling in the soil. Like urease, amidase also acts on nitrogen as well as carbon compounds and end product is Ammonium ($NH_4$).

**Acid and Alkaline Phosphatase:** This enzyme helps in catalyzing the hydrolysis of esters and also anhydrides of phosphoric acid and solubilizes phosphorus in phosphate form. It is an important parameter of Phosphorus recycling process in the soil.

**α-Amylase and β-Amylase:** These two enzymes take place in starch hydrolysis and form glucose and maltose. It is an indicator of proper carbon cycling in the soil.

**Dehydrogenase:** It takes place in oxidation-reduction reaction. In electron transport system of respiration, it transfers Hydrogen atom to NAD or NADP. It indicates the status of oxidative activity in microbial cells.

**Endo-1,4-β- glucanase and Exo-1,4-β- glucanase:** Substrate of these two enzymes is cellulose and forms glucose and cellobiose. It indicates the carbon cycling in soil.

**Phenol oxidase:**It helps in lignin hydrolysis and forms various humic substances. It indicates the carbon cycling in soil.

**Arylsulphatase:**It enhances the hydrolysis process of sulfate esters and form inorganic form of sulphur, sulfate which is available to plants.It is an important parameter of sulphur recycling in the soil.

**Protease:** It helps in Nitrogen mineralization and make inorganic form of nitrogen to the plant. It indicates the nitrogen cycling in soil.

**Chitinase:** From the name of this enzyme, it is clear that it degrades the chitin and form carbohydrate and nitrogen in inorganic form. It indicates the status of carbon and nitrogen cycle in the soil.

**Beneficial microorganism in soil and their function:**

Soil is a source of a wide range of pathogenic and beneficial microorganisms. Pathogenic microbes cause diseases in plants through root colonization, or sometimes they are spread by soil. Similarly, helpful microbes colonize the root and soil, compete with the pathogenic microbes and inhibit their growth. These beneficial bacteria have immense effects on sustainable crop production and disease management. The major functions are (Davison, 1988):

1. To enhance growth of the plants.
2. To make nutrients available to plants.
3. To manage the disease-causing pathogens.
4. To improve soil health,
5. Bacterial quorum sensing mechanism can be used in bioremediation of heavy metals and organic pollutants (Middledrop *et al*., 1990, Zaidi *et al*., 2008, Burd *et al.*, 2000).

For sustainable agricultural practices, biocontrol agents are a good alternative of chemical pesticides and for these plant-microbes interaction is very important. Plant growths promoting Rhizobacteria (PGPR) or Plant Health promoting Rhizobacteria (PHPR) colonizes the plant root and imposes beneficial effects through direct and indirect mechanisms **(Sturz** *et al.,* **2000 and Shoebitz** *et al.,* **2009).** There are mainly two basic type of association between plants and microbes like: Symbiotic bacteria (*Rhizobium* sp., *Bradyrhizobium* sp., *Azorhizobium* sp.)
**(Kennedy** *et al.*, **2004)** and Non-symbiotic or free living bacteria (*Azospirillum* sp., *Enterobacter* sp., *Pseudomonas* sp.).Symbiotic bacteria colonize inside the plant cell and form nodules and free-living bacteria do not produce nodules and colonize the root cells **(Gray and Smith, 2005).**

**Mechanism of plant grow by PGPR:**

PGPR increases plant growth by two mechanisms like a) Anti-microbial actions and b) Plant growth promoting mechanisms.

**Anti microbial actions:**

**Rhizosphere colonization:** By colonizing plant root microbes impose a competition of food and space to the pathogenic fungus and bacteria by colonizing root (Kloepper and Schroth, 1978, Cleyet- Marcel *et al.*, 2001).

**Production of Volatile and Non-volatile antimicrobial compounds and HCN:** Biocontrol agents release some chemicals which inhibit the growth of pathogens. Sometimes bacteria release antibiotics and hydrogen cyanide (HCN) to prevent the pathogens growth(Haas and Keel, 2003).

**Siderophore production:** Siderophore production is another kind of adaptation of beneficial microbes to resist the harmful effects of pathogens to the plants (Dobbelaere *et al.*, 2003; Glick and Pasternak, 2003).Siderophore is a low molecular weight, iron chelating compounds. Microorganisms remove the iron from the soil environment and form a competition for the iron between beneficial and harmful microbes (Persello-Cartieaux *et al.*, 2003). Bacteria like Pseudomonads group, *Streptomyces* sp., and Frankia (Boyer *et al*., 1999) has been reported to form siderophore.

**Production of cell wall degrading enzymes:** Bacteria produce various hydrolytic enzymes like α-amylase, cellulase, pectinase, protease, dehydrogenase, chitinase and β-1,3 glucanase (Bloemberg and Lugtenberg, 2001)by which bacteria degrade the cell wall of pathogenic bacteria and fungi.

**Plant growth promoting mechanism:**

**Production of Plant Growth Regulators:** PGPRs produce some phytohormones, and these are called Plant Growth Regulators (PGRs). Some important PGRs are Auxin, Cytokinin, Gibberellin, Abscisic acid and Ethylene (Zahir *et al.*, 2004). Amongst them, Auxin is the most essential and common phytohormone, which has an immense effect on plant growth and development. Indole acetic acid helps in plant cell elongation, cell division and differentiation (Patten and Glick, 2002). Many PGPRs produce cytokinin under in-vitro conditions. Cytokinin also plays an essential role in plant physiology. Gibberelin helps in stem elongation (Davies, 1995). Abscisic acid is important for plant growth under water-stressed semi-arid and arid conditions. This hormone also helps balance water equilibrium in plant physiology by controlling the stomatal opening and closure (Frankenberger and Arshad, 1995). Ethylene is also an important phytohormone having immense effect on fruit ripening, root hair and adventitious root development. Many PGPRs synthesize ethylene (Primrose, 1979).

**ACC Deaminase activity of PGPRs:** PGPRs have ACC Deaminase activity by which they can hydrolyze the 1-aminocyclopropane-1-carboxylate (ACC) and form α-ketobutyrate and ammonia. These two compounds act as Carbon and Nitrogen source of bacteria and utilizing this PGPRs can grow; simultaneously this reaction somehow helps the plant from the deleterious effect of Ethylene (Saleem *et al.,* 2007). As 1-aminocyclopropane-1-carboxylate (ACC) is the precursor of Ethylene biosynthesis. Ethylene inhibits the root growth of higher plants, by hydrolyzing ACC, PGPRs also can prevent ethylene biosynthesis, reduce the ethylene concentration in soil microclimate and ultimately enhance plant growth. PGPRs with this property not only can help in plant growth, but they also can increase the yield and can serve as a good biofertilizer (Shaharoona *et al.*, 2006).

**Minerals solubilization:** PGPRs have the ability to solubilize the minerals of Nitrogen, Phosphorus, Potassium, Zinc etc. They make the minerals available to the plants in inorganic form and help enhance the plants' stress resistance, increase soil organic matter content, improve the soil structure by supplying essential minerals, and help reduce the application of chemical fertilizers (Miller and Jastrow, 2000). Phosphate solubilizing bacteria have some special genetic composition that helps them enhance the solubilization process and improve plant growth (Rodriguez *et al.*, 2006). Gene, involved in phosphate solubilization process, was first cloned by (Goldstein and Liu, 1987). That entire experiment was done on *Erwinia herbicola*, a gram-negative bacterium.

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**Bioremediation:** Bioremediation is an emerging trends now-a-days. Using bacterial quorum sensing mechanism, we can use the PGPRs to neutralize the heavy metals (Narasimhan *et al.,* 2003). Some PGPRs uptake the Ni from the soil matrix (Abou-Shanab *et al.,* 2006). *Pseudomonas* sp., *Ralstonia* sp. And *Methanobacteria*spp. may also help in bioremediation.

**Impact of different ecosystems in soil enzymes:**

Earlier, we have discussed that the soil enzymes have an immense effect on the soil's organic matter content, recycling essential nutrients like Carbon, Nitrogen, Phosphorus, energy transfer, etc. Soil enzymes play a vital role and are significant indicators of soil health status. So, this is clear that different ecosystems and different crop management practices, cropping pattern, and tillage operation directly influence soil enzymes' activity (Srinivasarao *et al.,* 2014). The difference in soil enzymatic activity is due to various management practices that are prominent in the surface soil and the effects are reduced with increasing soil depth. Organic manure like vermicompost, FYM, green manure increase the soil nutrient status, fertility, soil organic matter and enhance acid phosphatase, urease, dehydrogenase, β-glucosidase enzyme activity (Srinivasarao *et al.,* 2013) and (Mandal *et al.,* 2007). It was reported that in rice-wheat cropping system, maize residue increases the activity of invertase, alkaline phosphatase, dehydrogenase, protease and urease and also increase soil organic carbon (Tao *et al.,* 2009).

In legume based crop rotation, conservation agriculture increases dehydrogenase activity (Roldan *et al.,* 2005). In forest soil β-glucosidase, alkaline phosphatase activity is comparatively higher than agricultural soil. Urease activity is highest in pasture soil (Kizilkaya *et al.,* 2010). In Soils which are degraded by continuous cultivation and natural weathering**,** there enzymatic activity is low (Araujo *et al.,* 2013). In Polluted enzymatic activity in soil is also low. Monocropping can also reduce the soil enzymatic activity.

**Factors influencing enzymatic activities:**

From the previous discussion, it is clear that soil enzymatic activity is affected by different cropping system, soil management practices and cultivation practices. So, several factors influence soil enzymatic activity. Those are Anthropogenic or artificial and natural. Agricultural practices, application of chemical pesticides, fertilizers, environmental pollution caused by residual effects of chemical compounds come under anthropogenic factors and natural factors are geographical, physical, geological, chemical. These factors alter the catalytic property and structure of the active site of enzymatic substrates.

**Some factors which influence the activity of the specific enzymes are as follows (Srinivasarao *et al.,* 2017):**

| Enzymes | Factors |
|---|---|
| Endo-1,4-β- glucanase & Exo-1,4-β-glucanase, β-glucosidase | Soil water content, soil pH, temperature, soil organic matter |
| Dehydrogenase | Soil management practice, chemical compounds like pesticides, pollution, soil temperature and water. |
| α-Amylase & β-Amylase | Soil environment, vegetation |
| Alkaline and Acid Phosphatase | Crop varieties and species, soil organic matter |
| Arylsulphatase | Presence of sulfate esters as substrate, pollution due to heavy metal |
| Protease | Carbon and nitrogen concentration in soil matrix, concentration of humic acid |

| | |
|---|---|
| Chitinase | Depth of soil, $CO_2$ concentration in air, Nitrogen availability in soil |
| Urease | Soil organic matter, cropping pattern, heavy metal concentration |
| Phenol oxidase | Average annual rainfall, temperature, nitrogen content |

**Future prospects:**

Soil enzymes play a vital role in maintaining soil health, increasing the fertility of the soil and microorganism activities in the management of the ecosystem. They have significant effects on the growth and uptake of nutrients in plants by altering the soil biology. However, apart from cultural management practices, cropping system, and availability of organic matter in the soil various other factors are unidentified. Therefore, studies must focus on those aspects so that sustainable crop growth can be achieved. Beside these many new enzymes which has not been identified may persist in the soil that may be helping the soil directly or indirectly in maintaining a healthy soil environment for microorganism population build up and plant growth. Such areas and knowledge gap have to be fulfilled with some quality research and knowledge's that may positively influence promoting the ecofriendly environmental condition for sustaining not only plants but also other living beings.

**Conclusion**

Soil enzymes have a significant effect on soil physical, chemical, and biological property and agricultural productivity. Simultaneously PGPRs play a role in making the soil enriched. There is an interaction between the PGPRs and soil enzymes. PGPRs increase the soil enzymatic activity helps in reducing the pathogenic population in soil and increasing plant growth. Soil bacteria solubilize the essential mineral nutrients and make them available to the plants in inorganic form, soil enzyme also acts on their substrate and supply nutrients to the plants. This is how soil enzymes and beneficial soil microorganisms help in sustainable agriculture by reducing the application of chemical compounds.

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# Rural Settings on Changing Climate through Participatory Approaches

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## ABSTRACT

***The present study entitled "Rural settings on changing climate through participatory approaches"had been initiated focusing on the adaptive capacity of farmers to drought.Different PRA tools were used in the present investigation in 2017 year. For this study one NICRA adopted village of Anantapur district from the Andhra Pradesh state was selected purposively, as they were covered under NICRA, where the CRA technologies introduced. The gathered information from PRA techniques which have conducted in NICRA adopted village Peravali in Ananthapur district with the active participation of farmers were excavated percolation tanks, constructed check dams. There was increase in underground water level (15 feet) due to excavation of percolation ponds. In the year 2014, under NRM module, one check dam was renovated at Peravali village. Farmers sown ground nut crop in first fort night of July with 20 mm rain fall only. The crop was subjected to prolonged dryspell at moisture sensitive stages resulted drastic reduction in yield. Some farmers sown sorghum, green gram, korra and guar crop in the month of second fort night of August, as contingent crops. Farmers were also cultivating on the slopes using with stone bunds. Also observed that in some places fodder, orchards like sweet oranges, banana, pomegranate, sapota, jasmine, lilly flowers and curry leaf and some other vegetable tact for household consumption where the water facility occurred. They were also doing contour cultivation and dug out contour trenches on hills. Animal husbandry with hay stocks, goats and poultry observed near the residential area. The farmers took farm implements on hiring basis from custom hiring centres.***

**Keywords:**CRA,NICRA, PRA.

## Introduction

National Initiative on Climate Resilient Agriculture (NICRA) has three major objectives, to enhance the resilience of Indian agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies; to demonstrate site specific technology packages on farmers' fields for adapting to current climate risks; and to enhance the capacity building of scientists and other stakeholders in climate resilient agricultural research and its application. Keeping this in view the present investigation entitled as "Rural settings on changing climate through participatory approaches" was undertaken in the year 2017. For this study Anantapur district from the Andhra Pradesh state was selected purposively, as they were covered under NICRA, where the CRA technologies introduced. For this study one NICRA adopted villagePeravali was selected from Anantapur district.The annual rainfall of Peravalivillage was 498 mm.The major crops grown here are ground nut, red gram than horse gram, korra, green gram, sorghum as dual purpose, fodder crop. The crops were cultivated in red soils in rainfed condition due to low water table and poor water holding capacity of red soils. Other crops include vegetables such as tomato, cucumber and ridge gourds, curry leaf and some leafy vegetables. Jasmine, Lilly flower crops. Among trees, we could observe neem, eucalyptus, tamarind, pongamia, amla tree, sweet oranges, banana etc. Shallow depth of the soils and low water holding capacity, saline soils were the major soil constraints.

In this study the rural settings to overcome the drought were analysed through selected PRA tools by community farmers. For this village resource map, transect walk, agro- ecology map and seasonal calendar were selected from a range of tools of the PRA.

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**Village resource mapping:** Village mapping is the method used to help the village people to know and understand clearly the actual situation of the villages. It provides the information on how the village is being utilized. The village mapping is used as a mirror to see clearly and identify problems and potentials of the village. This indicates both the natural resources and man-made resources needed for development of agriculture. Ensure the participation of all stakeholders (male, female, old, young and children). Depict main crops, trees, animals, farm implements, communication items, human resources for agriculture like skilled labour, technical manpower etc. The village resource map shows the different kind of natural and manmade recourses such as land, vegetation, common land use, soil, water, minerals, transport and source of communication and different supply and service organization.

**Transect walk:** A transect is a walk across the village following a predetermined route on the map which indicates environmental, physical and socio economic diversity. It involves recording the landscape, soil types, vegetation, farming activities degradation and tendencies, services. The walk verifies what has been indicated on the map. It enriches the resident's knowledge about their village and fills in the information gaps missed during mapping. The farmers appreciate this trip to the field for it helps them to internalize problems related to farming, activities, which affect development.The transect is made by mixed sub groups with representatives from various socio interest groups. Each subgroup should select a recorder to take notes of what will be observed. At the end of the walk the information collected from the transect conducted is presented in a tabulated form. The drawing is made by the recorder with the help of sub groups.

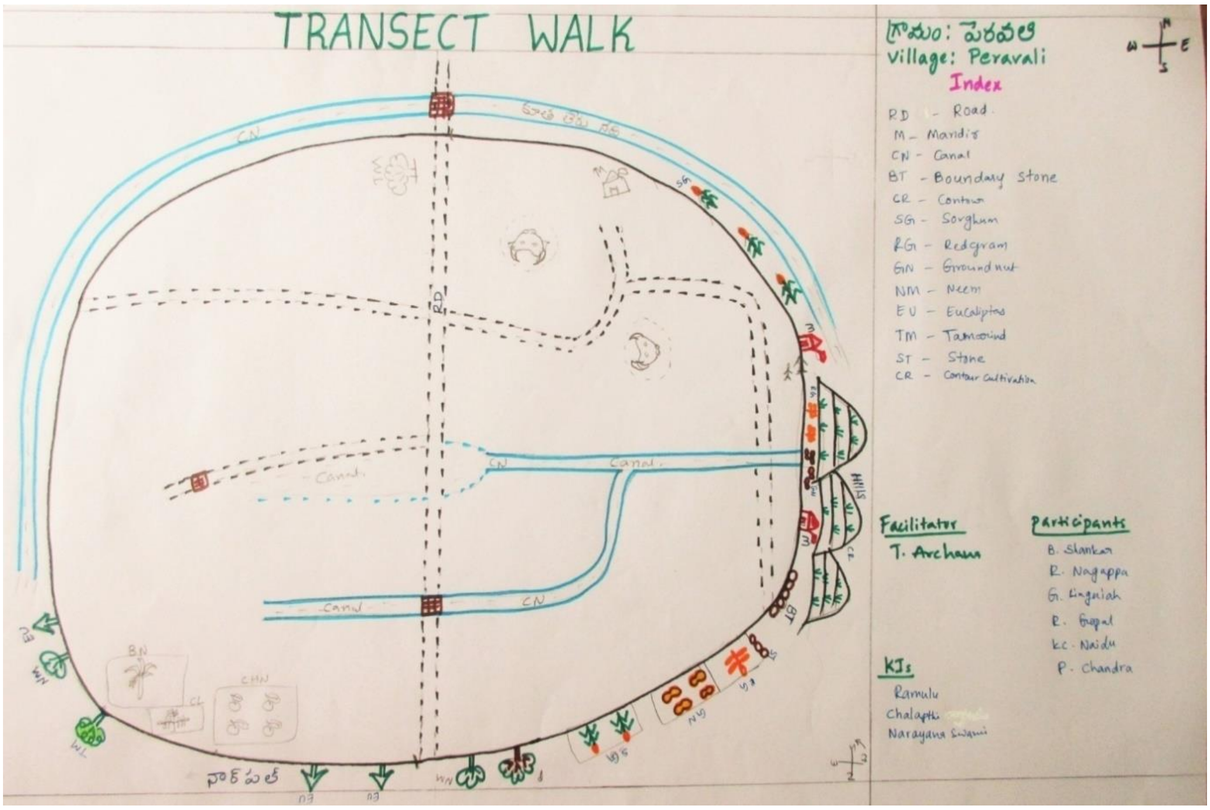


**Fig. 1 An illustration of a transect walk of Peravali village of Anantapur district**

**Agro-ecology map:** Agro ecological map was drawn to identify the various agro ecological zones present in the village. Special emphasis was given to mark the various crops, soil types, water bodies, weeds, water sources and irrigation system, livestock, trees and other aspects related to agro-ecology.

**Seasonal calendar:** This is a calendar which indicates month wise, abnormalities, specialties, threats, problem, abundance, shortage, with regard to agriculture in a dramatic way. This explores seasonal constraints and opportunities by diagramming changes, month by month throughout the year. The items to be included in seasonal analysis must be of those items, which really affect the agriculture.The entire agriculture is based on season. For preparing realistic action plan, farm plan, need based extension programme and need based technology development project, seasonal analysis will be a boon. In this present study it is prepared for climatic variations (rain fall, temperature and humidity) by diagramming changes, month by month throughout the year. The climate plays an important role in agricultural development of an area. The rainfall, temperature and relative humidity affect the cropping pattern, crop production and adoption of crop technologies. The growth, health and yield of a crop are greatly influenced by the climatic factors.

**Discussion**

**The analysis of rural settings based on information got through various PRA techniques done in Peravali village in Ananthapur districts of Andhra Pradesh state**

**Village transect**

Key Informants: P. Chalapathi Naidu, P. Ramulu, A. Narayana Swami

The transect walk was carried out from north to west towards the south to east direction of Peravali village along with the above mentioned key informants covering an area of around 5 km. During transect each person of the group identified resource and allied problems. While carrying out the transect walk at most care was taken in noting down the land marks of the various natural, social and the other resources present in the area together with the boundary points. The transect walk map and transect axis were drawn by the farmers is given in Fig 1. Initiation of transect was from the north to west marked by temple area of Peravali village. This village is endorsed with resources like solar plant, white mineral, dairy units, agricultural fields, plantations, School, panchayat office, water tank, transformers etc. Religious institutions like temples, church and musjid were also present in the area. This village is bordered by NainaPalli village in the east, ChakrayaPeta in the west, Julalpuram village in the north and Narpalli in south. Most part of the village marked connecting the village to nearby town Anantapur.The village had been divided into three zones for the purpose of general transect. The first transect covered an area of 1 km, the second one 2.5 km and the third one 1.5 km. the soils were mixed both red and black in three different transects. In terms of vegetation, the number of trees found was more in the second transect. The number of trees found in the first transect were less. The crops were more in last one, but it was less in firs zone. Livestock was found in first transect. Bore wells, percolation tanks, canals and Kuthaleru River was passed around the boarder of village in first and second zones. Canals, bore wells, percolation tanks were present in last zone. Water table was found to be near in last zone (80-90 feet), it was 90- 100 feet in second zone and it was deep in the first zone (up to 350 feet).In Peravali village, investigator along with key informants observed the same. Red soil was pre-dominant in upland area whereas black soil was predominant in low land area due to alluvial material near the water reservoir.Red soil being poorly fertile due to low nutrient contents (N, P and K) and low organic matter requires more fertilizers for fulfilling the requirement whereas black soil is deep soil and contains high organic matter. The major crops grown here are ground nut, red gram than horse gram, korra, green gram, sorghum as dual purpose, fodder crop. The crops were cultivated in red soils in rainfed condition due to low water table and poor water holding capacity of red soils. Other crops include vegetables such as tomato, cucumber and ridge gourds, curry leaf and some leafy vegetables. Jasmine, Lilly flower crops. Among trees, we could observe neem, eucalyptus, tamarind, pongamia, amla tree, sweet oranges, banana etc.

The problems were different in different transects. Water scarcity in summer, labour and drainage canal were the problems, in first transect. Water scarcity, Pest and diseases and labour were the important problems in second transect. Water scarcity, Pest and diseases and low water table and labour were reported as important problems in last transect. Improving the soil moisture conservation measure, labour banks, construction of roads in village, construction of godowns had good opportunity in first transect. There is scope for improvement in flower, forestry, and fodder cultivation. Renovation of soil moisture conservation measures, Labour bank and integrated pest management can be practiced to stop the attack of the pests in all zones.

**Resource map**

Key Informants: P. Chalapathi Nayudu, P Ramulu and A. Naryana Swami

Village mapping is the method used to help the village people to know and understand clearly the actual situation of the villages. The map was drawn by the farmers is given in Fig 2. Major crop was ground nut. Other like Ground nut and red gram as inter cropping, red gram, green gram, horse gram, sorghum, sweet oranges and banana orchards were present. Lilly and jasmine flower cultivation was also present. Vegetables like tomato, brinjal, cucurbits and curry leaf were present. Farmers were keeping stone checks around fields where the slope was present to control the runoff and to maintain soil moisture. Animals, farm implements and transport in the area are represented in this map. The main source of irrigation for the farmers is the Kuthaleru River which runs along the boundary starting from west, flowing through east. Apart from this bore wells, percolation tanks, and check dams available all through adds to the irrigation source of the village. Two water tanks and two hand pumps were also present in the village. Resources like one school, panchayat office and one church were present at entry point of the village and transformer was present. Three temples were also present. As far as the agricultural machinery is concerned, the farmers of this village were using implements from CHC on hiring basis to do the farm operations and some drip irrigation motor sets by farmers for fruit trees. The village has a little area under contour cultivation on one side of hills. The cropped and village residential areas have predominantly red soil. In the residential area livestock like cattle, goats, poultry were the important enterprises available. Coconut, eucalyptus, Pongamia, Prosopis and Neem trees are present along roads and canals. KVK was supplying seed varieties of major crops. However for most crop inputs like fertilizers, pesticides/ fungicides, high quality seeds etc. The farmers are dependent on external sources like shops in Ananthapur town.

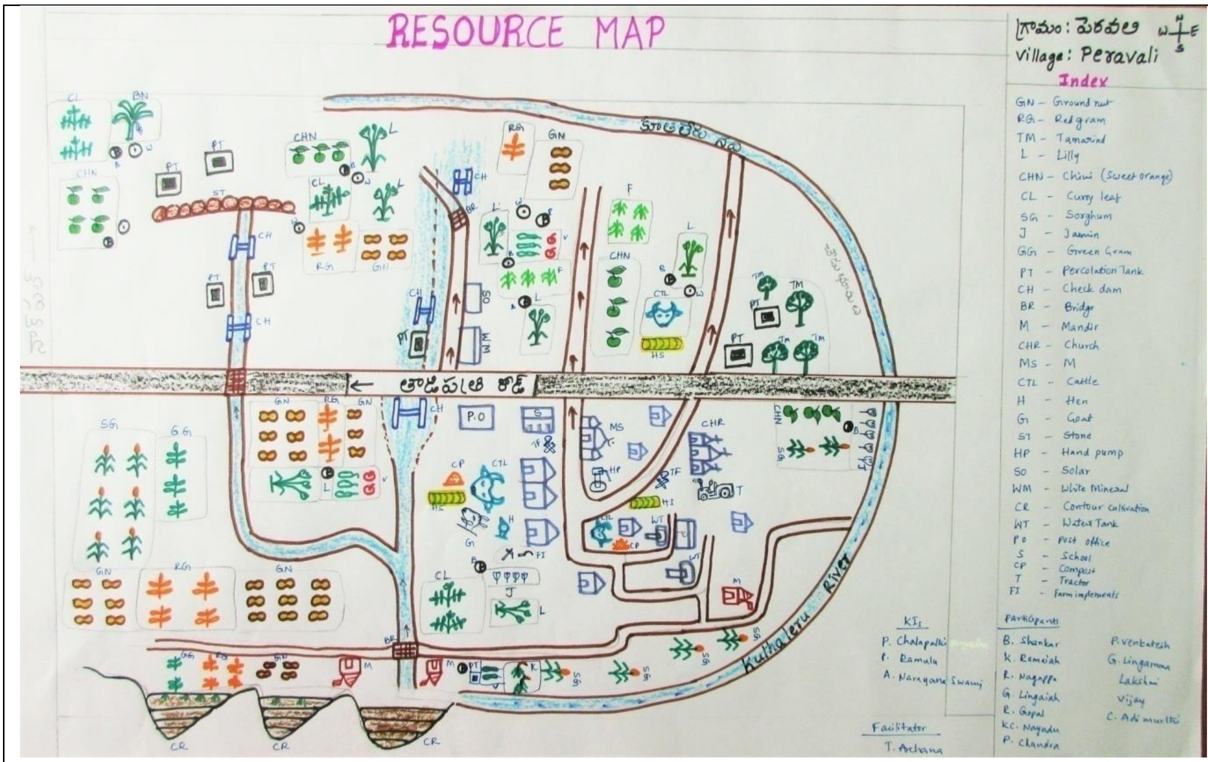


**Fig.2 An illustration of a resource map of Peravali village of Anantapur district.**

**Agro ecology map**

Key Informants: P. Chalapathi Naidu, P Ramulu and A. Narayana Swami

Agro ecological map of the village ChakrayaPeta was drawn by farmers to identify the various agro ecological zones present in the village. The farmers were encouraged to draw the agro ecological map themselves marking the important landmarks. Special emphasis was given to mark the various topographical areas, cropping pattern and crops, soil types, water bodies, weeds, water sources and irrigation system, livestock, trees and other aspects related to agro ecology. Major landmarks used to differentiate various zones in the map include important road which was west to east direction (Anantapur to Thadipatri route) dividing the village in to two parts. Due to this village people were doing cultivation in these two parts, one was near the national highway and second part was having bulk of the fields near the hills. Kuthaleru River was passing around border of the Peravali village from Narpalli village to Julalpuram. Major crops were ground nut + red gram under rainfed and other crops were dual purpose sorghum, black gram, green gram, horse gram, korra, fodder. Isolated small areas in this zone were under sweet orange orchards. Apart from this the farmers were growing vegetables like tomato, brinjal, ladies finger for domestic consumption in this area.The residential area of the village mainly consists of houses but all of the livestock i.e. cattle, poultry, goats were also present in this area. Low and erratic rain fall, uneven distribution of rainfall, delayed monsoon and early cessation of monsoon were the major climatic constraints. 90 per cent of the area under red soils. Shallow depth of the soils and low water holding capacity, saline soils were the major soil constraints.The major source of water in the village for cultivation and household use was the bore wells. Trees like neem, prosopis, coconut, eucalyptus and tamarind were present continuously on sides of canal and roads. In this village water harvesting measures like percolation tanks were excavated, contour cultivation also practiced on hills to stop the run off and soil erosion, from hill side check dams were constructed, stone bunds also used around the crops where the soil was having slope around the crops to control the soil erosion and to store the soil moisture. The map was drawn by the farmers is given in Fig 3.

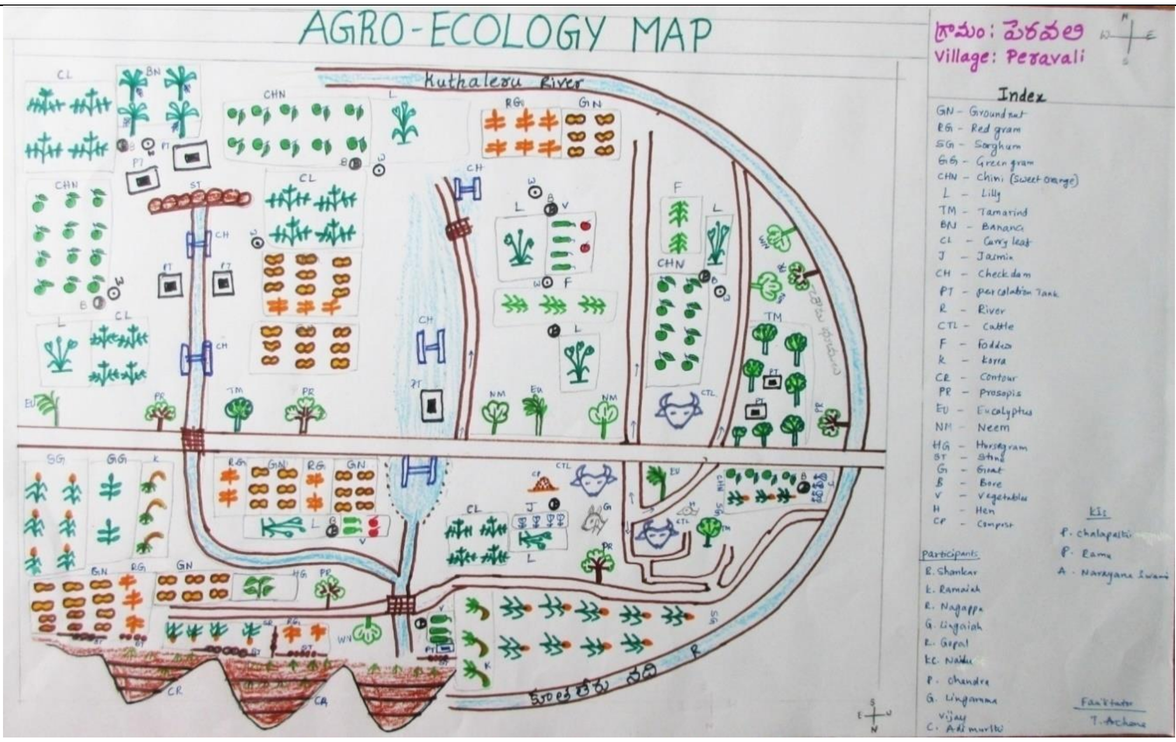


**Fig.3 An illustration of aagro-ecology map of Peravali village of Anantapur district.**

**Seasonal calendar**

Key Informants: P. Chalapathi Naidu, P Ramulu and A. Narayana Swami

The map was drawn by the farmers is given in Fig 4. The month wise analysis as reported by the key informants was as follows.

**January:** The temperature was reported to be very low and in case of humidity, it was high.

**February, March and April:** According to the key informants, temperature was increasing gradually during these three months. In the case of humidity used to go down during these three months.

**May:** The temperature was reported to be very high in this month, it would be 48oC, had dry season. This was the high temperature period. In the case of humidity, it was very low compared to other months.

**June:** It was the beginning of rain.

**June, July, August, September and October:** The rain fall was gradually increasing from June to September than used to go down completely in the month of October. The humidity was gradually increasing from June to October. In case of temperature it was used to go down during these months. These months had rainy season (moisture excess), this was the crop rowing period.

**November, December and January:** The temperature was used to go down. The relative humidity was in increasing trend during these months. These months had winter with mist with less temperature.

In the month January to march farmers did activities like harvesting their crops (sorghum, green gram, korra etc.), labour demand was less during these days. In the months of May to June they did land preparation and FYM organic manure application. During April and May months they did sheep penning activity to improve the soil fertility. In the months of June to July they had sown ground nut and red gram intercutivation under rainfed and they gave vaccination and de-warming their animals. From July to September they did intercultivation in crops. In the month of September, they had sown sorghum, green gram, some vegetables etc. The pest attack was more during October to December and in the month of December few farmers did de-warming their animals and labour demand was more for doing these activities during this period. Migration was more during January to May because of this was leas season, no water availability in the fields to do the farm operations. So they were migrating to Anantapur town for doing business activities.

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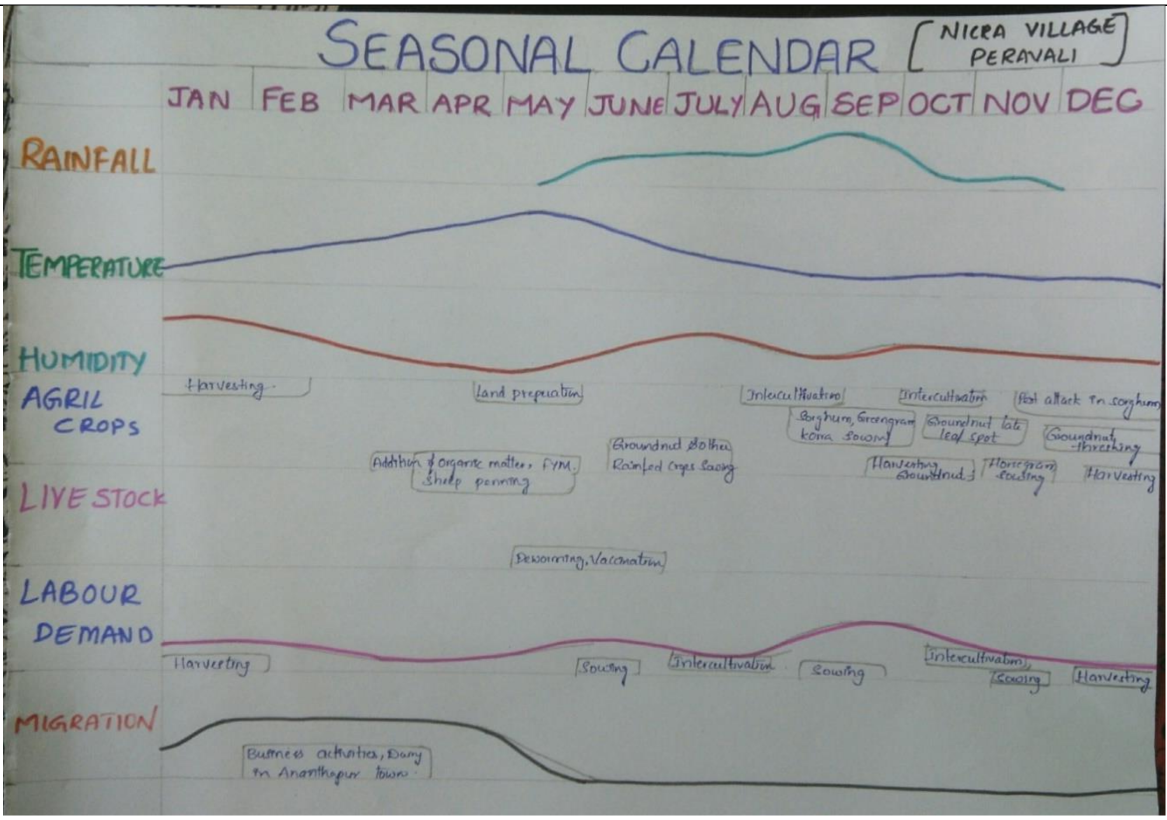


**Fig.4 An illustration of a seasonal calendar of Peravali village of Anantapur district**

## Conclusion

The rural settings to overcome the drought were analysed through selected PRA tools by community farmers. Village resource map, transect walk, agro- ecology map and seasonal calendar were selected from a range of tools of the PRA.Shallow depth of the soils and low water holding capacity, saline soils were the major soil constraints.The problems were different in different transects. Improving the soil moisture conservation measure, labour banks, construction of roads in village, construction of godowns had good opportunity in first transect. There is scope for improvement in flower, forestry, and fodder cultivation. Renovation of soil moisture conservation measures, Labour bank and integrated pest management can be practiced to stop the attack of the pests in all zones.

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# Water Losses in Tube Well Irrigation Area and Its Measures

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## Abstract

***With the exception of summer paddy, when farmers have a tendency to maintain the crop under continuous submergence, farmers typically follow suggested irrigation timing for other crops. The depth of ponded water, on the other hand, is determined by the land condition. Farmers commonly over-irrigate in uplands, and a portion of this water collects in lowlands via lateral seepage, resulting in further submergence. Overall seepage loss from field canals is estimated to be between 20 and 30 percent of the water diverted in our nation. In an irrigation command, excess loss via an unlined field channel decreases the irrigated area, generates extra water demand, and therefore raises the cost of cultivation. High seepage via the earthen channel, a zig-zag distribution system after the spouts, and inefficient water application have reduced irrigation command in West Bengal from 40 ha to 25-30 hectares for a DTW. Because 80 percent of total water is used to irrigate crop fields, there will be a significant shortfall in irrigation water unless the above-mentioned loss of irrigation water can be reduced to a significant extent by appropriate measures. This will result in a significant drop in agricultural production. Since 1996, a few kilometre canals of this sort have been built in various parts of the Nadia region with the help of public funds and farmer contributions. Longevity, carrying capacity, seepage management, and maintenance performance are all positive. More and more channels of this sort may be included into irrigation controls to reduce water loss and investment, both of which are becoming increasingly important.***

***Keywords:*** Irrigation, seepage, summer paddy, water demand and water loss

## Introduction

A deep tube well in the State of West Bengal has an For a country like India, where 17 percent of the world population lives on only 2.4 percent of the land, efficient use of existing water resources is critical. 4% of the world's water resources Furthermore, on a per capita basis in terms of average utilisable water availability resources, which were 5247 $m^3$ in 1951 (and are still 5247 $m^3$) 1453 m3) is anticipated to drop to 1170 m3 by the end of the year. by the year 2050 (CWC, 2015). The agricultural sector alone uses 80% of the groundwater. The falling trend of groundwater levels across the country also suggests that ensuring a reliable supply of high-quality water will become a problem for the country's growth (Manivannan *et al*., 2017).. The flood irrigation system's total efficiency ranges from 25 to 40%. (Amarasinghe, 2007). In terms of water usage efficiency, energy savings, yield growth, and net return per unit volume of groundwater, micro irrigation outperforms other standard irrigation systems (Kumar and Palanisami, 2010; Chandrakanth *et al*., 2013). To satisfy the anticipated population's food security, economic, and nutritional demands in 2050, India's food output will have to nearly quadruple. With the installation of different artificial conservation measures, the groundwater table can be enhanced, as can agricultural yield (Paul and Panigarhi, 2016). Between 1991 and 2007, India invested approximately $4 billion in public canal networks (Dhawan, 2017). Despite this, the canal-irrigated area declined by 38 lakh hectares during that time due to outdated infrastructure, poor water delivery, and a lack of incentives. This means that "our administrations have not been able to halt groundwater depletion despite significant public investment on canals." The main reason is the growing disparity between irrigation potential produced and actual use. Punjab, Uttar Pradesh, and Uttarakhand have the largest reliance on ground water for irrigation (79 percent of the land watered is by tube wells and wells), followed by Uttar Pradesh (80 percent), and Uttarakhand (80 percent). According to a 2013 estimate by the Central Ground Water Board (CGWB), India's total yearly replenishable groundwater resource is about 433 billion cubic meters (BCM), with a net annual groundwater availability of 398

BCM, of which India withdraws 253 BCM (62%) per year. Around 39% of wells, according to the CGWB, are exhibiting a drop in groundwater level. Based on the stage of groundwater removal as well as long-term drop in groundwater level, 1,034 assessment units (in 15 states and two union territories) have been classed as "over exploited" (CGWB, 2017).Average discharge of 2 cusecs and made to irrigate 40 ha land. In an irrigation command the cropping sequence followed by a farmer depends on crops suitable for that area, socio-economic status of farmer and market demand. Tube wells are usually idle in *kharif* season excepting some supplemental irrigation for winter paddy, but in much use during non-monsoon seasons. However, the utilization pattern of a tube well mostly depends on the cropping system followed in *rabi*- summer months. It is observed that total days of operation in whole area decrease with increases in area under summer paddy though the total running hours gradually increases. Assuming gross water requirement of summer paddy as 125 cm, it is calculated that a deep tube well can irrigate only up to 65% of the irrigation command. Under such situation, the farmers usually keep the remaining portion of land as command fallow on rotational basis, thereby, decreasing the use efficiency of the system. For higher productivity, farmers usually prefer medium and long duration paddy varieties where irrigation is required till the last week of April when water table recedes to an alarming depth. For irrigation under such condition, farmers usually lower their shallow machine to a depth of 2-3 m below the ground level. Unlike major irrigation commands, farmers generally follow recommended irrigation scheduling for most of the crop exceptions summer paddy where the farmers have a tendency to keep the crop under continuous submergence. However, the depth of ponded water depends on the land situation. Farmers usually over irrigate in uplands and a portion of this water through lateral seepage accumulates in low land resulting deeper submergence. In our country overall seepage loss from field channels has been estimated to be between 20 to 30% of the water diverted. The excess loss through the unlined field channel in an irrigation command reduces the irrigated area, causes the excess water demand and thereby increases the cost of cultivation. In West Bengal, high seepage through the earthen channel, zig-zag distribution systems after the spouts and inappropriate application of water have decreased the irrigation command roughly 40 ha to 25-30 ha for a DTW.

Unless the loss of irrigation water as stated above could not be reduced to considerable extent by appropriate measures there will be a great shortfall of irrigation water resulting much fall in agricultural production since 80% of the total water are being utilized in irrigating the crop fields.

**Forms of Water Losses**

There are several ways to cause water losses in tube well irrigation. Those are enumerated as below.

**(i) Seepage through the earthen channels**

Seepage is the downward and lateral movement of water from the wetted area of the channel **(Fig.1).** It is the continuous process as long as the water is available in the channel and the rate of it mainly depends on the soil characteristics. The coarse soil should have higher seepage loss.

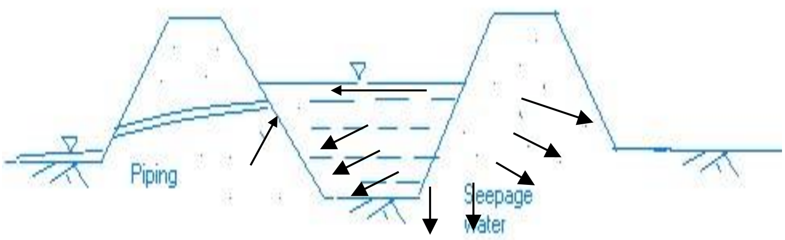


**Fig 1**. Water losses through seepage, cracks & holes

**(ii) Losses through cracks & holes**

The cracks and holes in the channels are developed due to activities of the burrowing animals and the passages created by the degraded roots of the weeds grow in the channel and channel banks **(Fig. 1).**

**(iii) Overflow through the channel for low flow velocity due to weed infestation and poor maintenance and low height channel banks**

Loss of water also takes place due to poor maintenance of channel. It allows growing weeds causing reduction in velocity of flow. The depositions of soils in the channel and settlement or soil eroded from channel banks reduce water carrying capacity of the channel **(Fig.2).**

**Fig.2** A root infested low height bank channel

**(iv) Poor application efficiency due to low discharge, uneven land leveling & flood irrigation**

The application efficiency is determined by the percentage of water retained in the root zone depth to the water applied to the crop field. Water applied to the field advances further only after satisfying the infiltration requirement. Thus, major volume of low discharge contributes to the head end of the field. The uneven field does not allow uniform advancement of water. The depression or low spots hold good amount of water and get enough infiltration opportunity time. The flood irrigation usually has less uniform application of water due to spreading of water in large area **(Fig 3).**

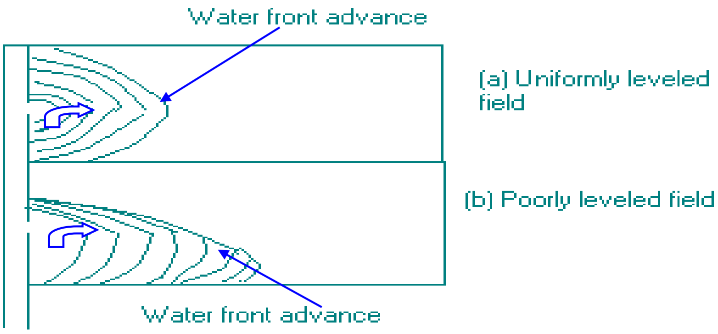


**Fig 3.** Water advance over the irrigation field

**(v) Faulty method of channel construction**

The bottom of the field irrigation channel should be on the ground level or little below the ground level so that the most of the water get delivered to the field when irrigation is stop other than it will provide necessary head of water for easy and sufficient discharge **(Fig.4**). However, this takes more area of land for channel construction. The farmers prefer deep and small width channel to save the land and maintenance costs **(Fig.5).** The loss of water apparently does not make them worried due to tax they use to pay for water on the basis of area irrigated.

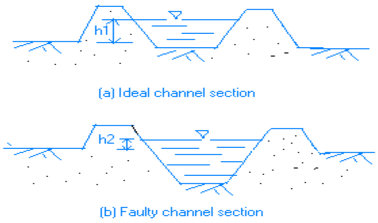


**Fig 4. Ideal & faulty channel sections** **Fig 5. Deep channels with low height of banks**

**(vi) Channel slope usually not in conformity to the natural land slope**

The field irrigation channels usually follow the boundary of the field plots. The direction is zigzag and the slope it follows always not downward **(Fig.6).** This cause some time reverse water pressure-causing overflow of water and much decrease in flow towards downward. The low discharge takes much time to cover a plot and huge loss of water in the system.

**Fig.6 Zigzag direction of the channel**

**(vii) Ponding of water at pump head and spout head**

The head end of a deep tube well usually creates sizeable water body by the accumulated water from the leaks of the pipe joints and discharge of overflow pipe **(Fig.7).** Similarly the falling water at the water outlet creates water body covering sizeable area**.** Both of these are the source of continuous loss of water through percolation and evaporation. It also cause loss of land and wetted surrounding area causing hindrance to usual cultivation practices

**Fig. 7 Head end of a deep tube well irrigation channel system**

**(viii) Wastage of water due to unavoidable excess pumping**

In a deep tube well there are usually 3 subsurface water carrying pipe originates from the pump. Each pipes distributed water to 4-5 spouts (water outlets) on the ground surface. A deep tube well usually has the discharge capacity of 40-50 l/s and the spout about 10 l/s. Therefore, when the tube well operates it needs 4-5 spouts opened to discharge the entire amount of water to the fields. However, situation arises when irrigation is needed only in the fields under the command of 2 or 3 spouts. In that case to save the piping system from excess water pressure, there is the provision to by pass the excess water. Huge water is regularly get lost by this way from the tube wells in upland areas where rice is not the major crop. A drain is required for safe disposal of this excess water (**Fig.8**).

**Fig.8 Drain for disposal of excess water**

### Percentage of Water Loss

In India about one third of the water diverted from the source is lost in conveyance. In the State of West Bengal 20-30% of the water get lost in conveyance in DTW or STW commands. The application losses of water widely vary in tube well to tube well depending on the soil, crop, land preparation, irrigation method and management. On a most optimistic assumption it should not be more than overall 75%. Let the loss of water due to compulsion of drain out of water at less number of openings of the outlets at a time than the optimum is only 15%. Say, 100 unit of water is diverted from the source. After compulsive drain out of 15 units the conveyance system will receive 85 units. On an average 25% conveyance loss, 63.75 units are to be delivered to the field. Out of these 63.75 units, the root zone depth soil will receive only 47.81 units and the remaining 15.94 units get lost through deep percolation. Therefore, the loss of water in an average tube well is 52.19%.

### Possible Measures to Seepage losses, losses through cracks and holes and low velocity of flow

These losses of water and low velocity due to weeds in the channel and the requirement of continuous maintenance of channel can be greatly reduced by lining the channel. Lining of irrigation channel means that the channel earthen surface is provided with a stable lining surface such as concrete, brick, stone, polyethylene etc. to minimize the seepage loss, protect the area prone to water logging due to rise in water table and to pass increased discharge through channel.

Bidhan Chandra Krishi Viswavidyalaya under the financial support of ICAR & CWC of Govt. of India conducted investigation with some low cost locally available materials. The following is the description of use of most successful and popular one used in lining the earthen channels of DTW/STW commands.

### Bamboo Reinforced precast half-round Concrete Section

These half round sections are 5 feet length and of desired diameter cast in designed mould **(Fig.9).** The reinforcements are used the bamboo sticks of 5mm x 10mm cross-section with the length of 150cm and spacing 10cm x 10cm or 15cm x 15cm. The coarse aggregates are the blast furnace slag pieces or quarter size stone chips. The casting of sections is very easy **(Fig.10).** The precast sections are carried to the formation surface i.e. bed of the channel and placed one after another**.** Both the outer side of the sections to be filled up by sufficient soils so that the sections get the required supports and remained fixed in the position. The 35.56cm (14 inches) diameter channel has been found adequate to the commands of DTW/STW where the outlet discharges are about 10 l/s. The seepage losses through these channels are found 6.844 $cm^3/cm^2$/day.

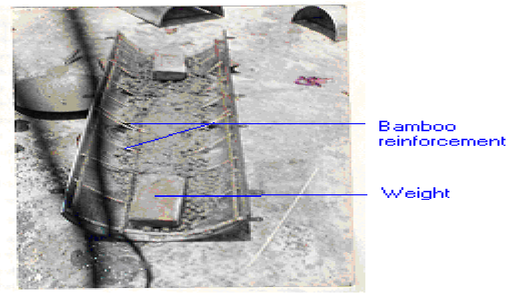


**Fig. 9** Progress of casting the half round bamboo reinforced precast section

**Fig. 10** A channel made of half round by jointing the sections

### Economy of constructional of channels

Among the conventional lining materials brick is the most popular in the locality. Therefore, cost of construction of lined channels under study was compared to the cost of construction of brick channels of comparable area of construction. The saving in cost of construction was 67.95% **(Table 1)**.

**Table 1**. **Cost and saving in construction of channels made of selected lining materials compared to brick lined channel**

| Type of lining materials and channel shape | Sectional area, $cm^2$ | Cost of construction, Rs/m | | Saving in cost for the channels, % |
|---|---|---|---|---|
| | | Channel | Brick lined channel of same sectional area | |
| Bamboo reinforced concrete half round section | 982 | 125 | 390 | 67.95 |

### Conclusion

So far few kilometer channels of this type have been constructed in different part of Nadia district in support of the public fund along with the farmers' contribution from 1996 onwards. The performance in respect to longevity, carrying capacity, seepage control and maintenance are encouraging. More and more channels of this type may be constructed into the irrigation commands to save the loss of water and the amount of investment, which have become very urgent.

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# Horticulture Based Agroforestry as a Tool for Sustainable Production

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## Abstract

***Indian agriculture relies on the mono-cropping farming that has significant constraints. Intercropping is the scientific approach which offer assurance against environmental threats and provides sustainable returns even under adverse climatic conditions. Crop intensification is advantageous over monocropping by land use management and is also supportive for more production on a given piece of land by utilizing expeditiously the available growth resources. Horticulture based agroforestry system establish proof to be more efficient practice through exploitation of the farm resources like water, nutrients so as to attain proper crop production. For successful outcome of this system proper selection of growth habit, root structure, canopy structure, nutrient necessities, height of the crop and harmonious utilization of growth resources by the interdependent crops is very important. Plantation of tree ,vegetable, fruits in the alley cropping system is a great success. In this system, annual vegetable like pea, cole crops, tomato, chillies, brinjal, tuber crops are the most associated vegetable crops. Fruit crops like mango, guava, citrus and tree species Leucaena spp., Gliricidia, Pigeon pea, Populus spp., Eucalyptus, Rubber tree are also the compatible crops which could be chosen in agroforestry system. The horticulture based agroforestry system maintains the soil fertility and helps in nutrient recycling through which the farmers can increase the productivity to meet the market demand and may earn high income which will finally boost up the economy of the country.***

**Key words**: Agroforestry, Fruit crop, Intercropping, Vegetable crop, Wood tree.

## Introduction

Agriculture is the main domain of Indian economy. Due to growing needs of food, fodder, feed, pulp, fruits and timbers, socio economic demand, degradation of natural resources and climate change performance of agriculture and horticulture crops are greatly influenced by facing diverse constraints and challenges. The growers expectation did not derive despite of horticultural crops have major contribution in India's GDP. For sustainable agriculture and to attain the rising demand of population crop intensification is the way to increase the crop productivity together with arable land expansion utilizing eco-friendly inputs. Cropping system and diversification of crops combine with suitable farming technology could able to manage the ever-increasing demand for varied merchandise and guaranteed financial gain. In developing countries cropping systems i.e. mono-cropping, double cropping and polycropping is followed to increase the agricultural production. These practices permit additional economical use of land, farm resources for sustainable crop production. Intercropping lets the farmers to produce the crops throughout the year. It protect the ground as a cover and soil from desiccation, erosion for extended amount than monoculture. Poly cropping maximize water use potency of the crop, maintain soil health and fertility, reduces soil erosion (Hoshikawa, 1991). As the planting and harvest time is different in intercropping it reduces the seasonal work engagements of the famers. Since cultivation of different crops at a time makes proper utilization of available nutrients and soil water, the farmers can meet the rising demand for food by sustainable production and independent sustenance.

## Discussion

Intercropping with tree species and horticulture crops is a tool for sustainable farming. It is a technique of crop intensification in both space and time where in the competition between crops may occur during the crop growing period. The designing the cropping system should based on the principles like: choosing compatible species, balance ecosystem, and reproducing succession (Lovell *et al.*, 2017). Small holding farmers are influenced to intercropping of young timber trees with annuals to supply nutrient and weed management edges to the trees while securing a short-financial gain on the land.

Intercropping of vegetable crops under canopy of fruit trees additionally does not have any adverse effect on vegetative and reproductive growth of trees. By exploiting theresources in intercropping of the vegetables under fruit orchard significantly improves the fruit tree health and improves productivity that bring about additional income to the farmers (Singh and Sharma, 2016).

**Research findings**

| | |
|---|---|
| **Abdel-Aziz et al. (2008)** | In citrus fenugreek as intercrop enhances of fruit set, vegetative growth and fruit yield with reduced fruit drop in citrus . |
| **Chaudhary and Deka (1997)** | Coconut yield (8365nuts/ha) increases by multistoryed cropping system Coconut + Betel wine + Banana + Assam lemon + turmeric + Colocasia cropping system followed by Coconut + Black pepper + Banana + Assam lemon + Pineapple +Ginger (876 nuts per ha.) in Assam in comparison to Coconut alone. |
| **Kumar et al.(2000)** | Tomato intercropped with papaya at 2.1 x 2.1 m of spacing resulted highest yield of papaya 99.77kg fruits per tree |
| **Lachungpa (2004)** | Intercropping of ginger, maize, finger millet, beans and vegetables under Kinnow orchard resulted maximum number of fruits. |
| **Singh et al. (2014)** | The highest fruit yield (24.74 kg/tree) was obtained by intercropping of arvi followed by suran (23.12 kg/tree) in guava plantation during winter season. |

It protects the soil from wind and water induced erosion and plays important role in natural resource conservation. The adverse effects of temperature and wind on soil fertility, biodiversityare reform by agroforestry system. The systems are eco-friendly and alternative source to food,wood production and also absorbsatmospheric carbon due to their quick growth and high productivity (Tiwari *et al.*, 2017). For the success of agroforestry plantation selection of tree species and identification of compatible crops under varying array of spacing and scarce solar energy available to understoryed is very important(Thakur *et al.*, 2018). The tree species check erosion and also ameliorate soil fertility through nitrogen fixing trees and improves organic matter, increase nutrient uptake from deep soil horizons by recycling through litter fall, pruning of twigs, dead root residues and also reduces the loss of nutrient through leaching . The modification in microclimate is one of the vital option of agroforestry (Kumar *et al.*, 2018).Satisfactory growth and yields of both woody and non woody plants can be achieved in the micro environment of the agroforestry land use system that is established, that differ significantly with time. In addition the legumes have great prospects for integration with horticulture crops in several ways. Legume tree cultivation in fallow land provides soil nitrogen through biological atmospheric fixation, helps in availability of phosphorous by solubilizing insoluble P in soil, improving the soil physical health, increasing soil microbial activity, recycling of organic matter and also suppress the harmful effect of weed (Ghosh *et al.*, 2007). It is a natural mini nitrogen generatorin the field and can play a vital role in increasing indigenous nitrogen production seven times rapidlycompared to natural forests (Pavlidis and Tsihrintzis, 2018). Legume tree offers advantages to mitigates the challenges of environmental pollution due to excessapplication of chemical fertilizers, air and ground water pollution, climate changes and depletion of biodiversity (Khan *et al.*, 2017).

In recent years, agri-horticulture systems i.e. integration of fruit trees with the agricultural crops are proved to be an important agroforestry system for improving the crop productivity, valuable by products, generating additional employment and sustainable use of natural resources. This type of diversification of alternate land use system with agroforestry could able to mitigate agriculture challenges.The choice of fruit and vegetable species must be categorized based on the zonal economic potential and distinct interactions between crops. The drought resistant fruit trees like bada Peelu, Indian jujube, Lasoda, Jhar Ber etc. are suitable for the area receiving rainfall less than 300 mm and bring forth profit to the farmers even under severe drought conditions. In Agri-horti system combination the fruits crops such as aonla, pomegranate, bael, date palm and tamarind can be grown in the area with less water supply facilities. Bhandari et al., (2014) reported that ber and pomegranate with mung bean provides good production and provides employment throughout the year even in less irrigation facilities. The Agri-horti-silvi culture is the another agroforestry system which area is expanding in highland cropping systems. In this system horticultural crops, tree species and fodder crops are being grown together on the same unit of land. The fast growing, deep rooted wood tree species in integrating with horticultural crop may increase the employment opportunity for the growers, local labours and small scale wood industries. Tree plantations provide food, fuel, forage, timber, and check soil erosion, which would help in creating suitable microclimatic conditions. In dryfarming region agri-horti-silvi system worked out with maximum production per unit area ,Yadav *et al.* (2013). It has been found that green gram and guar were grown as intercrops with old plantation of lime and Indian rose wood the seed yield of green gram (471.3 kg $ha^{-1}$)and guar (419.8 kg $ha^{-1}$) was recorded high as compared to intercropping with Indian rose wood. In another finding reported that intercropping under horti-silvi system with less water supply through sprinkler system in well set up citrus plantations, productivity of the crops is not hampered (Singh *et al.,* 2012). On the other side, only horticulture cropping has become problematic as the drainage outflow contains nutrients, salts and residues of agro-chemicals which pollute the water of reservoirs, river ,pond into which it is discharged . In response to this horticulture based agroforestry act as a rehabilitation process, ameliorate soil health and plantation of tree species purify the environment by absorbing gases like methane, carbon dioxide (Dhewa and Daniel, 2017). Alley cropping has potential to address the problems of foodinsecurity especially in developing countries and conservation of natural resources reducing vulnerability increasing durability of farming systems and households damage against climate-related risk in addition to providing livelihood security. This is a common agroforestry practice system combines both perennial woody crops and non-woody crops. Generally performance of C3 plants under shade grow better compared to C4 plants and could be selected for agroforestry practices .Trees are vital and essential for maintaining microclimates, and are well versed to accommodate with extreme weather adaption. The presence of trees controls microclimate in terms of temperature, water vapor content , wind speed, and helps to reduce heat stress of associated crops by lowering rates of foliar evapo-transpiration and soil evaporation (Jose *et al.*, 2004). The vegetables are arranged according to the spacing in between the woody perennials in order to avail both economic and environmental advantage of the farming system . Appropriate selection of tree, vegetable, fruits and tuber crops combination assured the success of plantation. Selection of non woody vegetables is very important as under shade rate of photosynsthesis and temperature are reduced, while the humidity is increased (Chauhan, 2016).The selection of the crop should be based on growth habit, agro-climatic and soil conditions, root system, water and nutrient demands. The crop should not compete with the companion crop, less susceptible to diseases , high rate of photosynthesis and biological fixation and shade-loving, (Dhakar *et al.*,2013). Above all the success of this system depends on the crop variety, management practice of crops and trees, variability of climate and socio-economic suitability contribute to system .The non woody vegetables provide steady income to the farmers during the early development stages of woody tree species and this system is economically attainable to protect crop from extremes microclimate. The farmers can adapt Horticulture based agroforestry system as a strategy in areas that may suffer from extremes climate to augment the crop yield and income.

## Conclusion

In present scenario of increasing population, unemployment, land acquisition for urbanization, deterioration of soil health, climate change are big threatening to food security. The agroforestry systems offers great potential to combat against these problems.This is due to the fact that tree and fruit plant do not affect growth and productivity of intercrops. Agri-horti-silvi system improves the organic matter in the surface soil which increases the infiltration capacity rather than sole cropping system. Alley cropping is also good for increasing food and wood production and protection against environmental menaces. Consequently it helps to impede degradation of land through soil erosion in high rainfall areas. Besides, intercropping of agriculture crops, silvi and fruit trees allows quick return during the growing period. Therefore, horticulture based agroforestry models can be grown profitably by small and marginal farmers.

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# Microbe Mediated Nutrient Transformations in Forest Ecosystem

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## Abstract

***Land is characterized universally as "a delineable space of the world's earthbound surface, incorporating all ascribes of the biosphere quickly above or underneath the surface, including those of the close surface environment, the organic matters and the landscape shapes, the surface hydrology (counting shallow lakes, waterways, bogs, and bogs), the close surface sedimentary layers and related groundwater which save, the plant and faunal populations, the human settlement design and actual consequences it has created over a significant period of time ."  Farming area is land that is arable and routinely harassed  for the creation of annual field crops, dry or irrigated. The word farming alludes to an expansive class of asset utilization that incorporates all types of land use for the creation of biotic harvests, regardless of whether animal or plants. In its broadest sense, rural land incorporates all land that gives direct advantages to humankind through the creation of food, fiber, organic matter, biofuel, along with wood. Natural or manmade  forest floor soils are regular bodies with an upward grouping of layers. At the top is a natural surface layer or "forest floor" (O horizon) with regions of new, undecomposed plant garbage (Oi horizon, earlier called L); semi-deteriorated, divided natural matter (Oe horizon, once called F) and humus; and nebulous natural matter without mineral material (Oa horizon, previously called H). Underneath this surface layer is a mineral surface horizon (A); a subsurface mineral horizon frequently drained (E); a subsurface mineral horizon with components of aggregation (B horizon); a mineral horizon vulnerable by roots (C); and locally hard bedrock (R). The E, B, C, and R horizon might be missing, or the B horizon might be altered by groundwater or stale water. This region contributes to enormous understanding in vertical and horizontal flow of nutrients***

**Keywords :** Nutrient cycles , Nitrogen , Phosphorus , Carbon , Dynamics

## Introduction

Farming soils related with rangelands and meadows regularly have comparable vertical groupings. Nonetheless, in case they are being developed (arable land)- or have been in the past-they might come up short on the O horizon (except if peat soils are being utilized), and the A horizon might have been blended in with parts of the E and surprisingly the B horizon, bringing about a furrow layer (Ap horizon). The B and additionally C horizons might have been separated by profound development. The organic matters might have been so corrupted by past human activities that they are presently not cultivatable. Such soils might in any case be delegated rural soils and utilized, for instance, for touching or non-trimming creation.

The thick natural layers of wetlands, which might have peaty horizons of in excess of 30 cm up to a few meters, are an extraordinary type of O horizon. These layers are significant stores of natural carbon, which might be delivered as $CO_2$ as well as $CH_4$ if the land is depleted and developed, misleadingly overflowed, or subject to fierce blazes in dry years. Both the organic matter and the earth are pertinent with regards to carbon sequestration in farming soils. The organic matter is the layer with collection of more labile soil natural matter ("nutrient humus"). More steady humus ("underlying humus") happens in both organic matter and earth. The movement of soil biota like rodents, night crawlers, termites, or leaf-slicing subterranean insects prompts a unique collaboration between these two layers and the foundation.

## Contrasts among farming and forest land

It is interesting to consider the impacts which farming has had on this planet over the millennia since it began. The change of forest to horticultural land has had various repercussions on the physical and organic climate. Transformation of forest lands into horticultural Lands

a. Increases albedo levels (the extent of light energy which is reflected from the land surface),

b. Increases heat movement

c. Reduces evapotranspiration from plants and trees,

d. Compacts soil (which expands precipitation overflow),

e. Increases disintegration, and influences air movement

f. Loss of biodiversity,

g. Movements of species all throughout the planet,

h. Shifts in nearby plant and creature populations,

i. The annihilation of biological systems, and

j. The break of endemic diseases.

Farming area contrasts in pretty much every regard from the forested land. The evacuation of the vegetation cover and its modification during the change of forested land to horticultural land has lead to:

a. Compound, physical and organic changes in soil: Due to conversion of forest land has led to varied changes in soil property (Hardoim *et al*., 2015)

I) Erosion: The expulsion of the vegetation cover for agrarian purposes diminishes the converse extent of precipitation consumed by the organic matter, prompting overflow and disintegration. The silting of streams, waterways, lakes and estuaries results, decreasing water supplies, and repressing photosynthesis in water plants. Disintegration also exhausts the nutrients in the organic matter, which implies that it can't support as much plant development as previously.

ii) Alterations in soil microorganisms: Soil microorganisms are firmly adjusted to their surroundings and the plants that occupy it, and they direct deterioration and nutrient accessibility in the organic matter. They are crucial additionally for the cycling of natural mixtures from soil to vegetation and back once more. Studies have shown that the assortment of species and the plenitude of life forms in the organic matter in tropical agrarian terrains is under half of that of the essential forest initially on that land (Lebeis , 2015)

iii) Loss of natural material in soil: During land transformation to horticulture, natural matter is lost from the organic matter. A significant part of the vegetation which gives natural material to the organic matter is eliminated, so there is less humus, the deficiency of which prompts adjustments in soil structure, diminished water maintenance, and brought down ripeness. In tropical soils changed over to horticultural purposes, soil carbon can drop over half inside five years.

iv) Soil compaction: When tropical soils are developed, they become considerably compacted. This is because of the utilization of large equipment, stomping on by animals, etc. The porosity of the upper layers is diminished, especially when the land is utilized for pasturage. At the point when porosity decreases, waste is poor and air dispersion diminished, which significantly changes the organization of the organic matter verdure by lessening their plenitude and biodiversity by more than 66%. These progressions might act to smaller the organic matter significantly further on the grounds that compacting and decompacting powers become unequal after deforestation.

b. Decreases in biodiversity: One of the more clear impacts of the transformation of forest land to horticultural utilizations is the deficiency faunal and floral diversity. Much of the time, the exceptionally perplexing environments of the woods are diminished to a basic arrangement of just one or a couple of harvests – cows, oil palm, or elastic. Many, if not most, rainforest creatures require either undisturbed woods or very much developed auxiliary backwoods. Many can't make due in little parts, as their reaches are excessively enormous, or their dissemination (particularly on account of trees) is excessively inadequate for satisfactory propagation (Baldrian, 2017).

c. Exhaustion of forest environments in light of the spread of microbes and the invasion of exotic species: Because of the commonness of monocultures and the importation of exotics, horticulture is an enticing gala for microorganisms, on the grounds that there are enormous stands of uniform hosts. Scourges in farming regions can spread to local woods, especially when they are divided. A sudden impact is that woods might be sliced trying to discover regions which are not polluted with the microorganism.

d. Compound pollution of soil and water and changes of regular mineral cycles (carbon, nitrogen, phosphorus): In a characteristic tropical rainforest framework, the contribution of gases and synthetic substances from the climate is roughly equivalent to the outgo, yet these associations with the external climate are little contrasted with the inward cycling of synthetic compounds from vegetation/creatures to soil and back once more. This cycling is seriously changed in horticultural frameworks since the amount of vegetation is tremendously decreased and the harvest is taken out from the framework, accordingly draining it of fundamental natural matter. Along these lines, nutrients should be included the type of manure (mostly nitrogenous). The utilization of compost adds one more measurement to this situation, as it generously changes the worldwide nitrogen cycle. Just 50% of the nitrogen and phosphorus from compost is used by the harvests; the other half remaining parts in the ground and enters the groundwater. Both phosphorus and nitrogen cause eutrophication of streams – nitrogen of estuaries and waterfront waters, phosphorus of lakes and streams. Eutrophication as often as possible prompts poisonous blossoms, the deficiency of biodiversity, and changes in species creation in oceanic environments. Nitrous oxides and alkali (a nitrogen compound, $NH_3$) enter the air and change climatic science; they add to the ozone depleting substance load, they add to corrosive downpour and are significant parts of brown haze. With everything taken into account, expansions in nitrogen and phosphorus levels can cause incredible misfortunes in biodiversity and extremist modifications of both amphibian and earthly environments. Pesticides utilized in horticulture are poisonous, and can harm contiguous woods. Some of them impersonate regular creature and plant chemicals and others are immunosuppressants, further harming the endurance of plants and creatures.

e. Adverse changes in water supplies and in streams: Irrigation of changed over lands prompts salinization (salt stores), water logging of soil, high nutrient levels in streams nearby rural regions and water exhaustion in streams, streams and other streams.

f. Dislodging of local species and disturbance of environments by the presentation of intriguing species: Many forest species are compromised by the attack of outlandish species presented either purposely as yields and domesticated animals or coincidentally. They essentially disturb nearby biological systems and drive misfortunes in the biodiversity of local species and populationss.

g. Soil exhaustion and loss of efficiency: Many ranches are set up by limited scope cultivators who follow logging streets into the backwoods ,the nutrient level of the land diminishes adequately, they forsake these homesteads and infiltrate farther into the virgin forest, abandoning debased fields.

h. Expansion in surface albedo and reduction in surface harshness, both prompting temperature increments and diminishes in precipitation.

**Properties Important For Plant Growth**

Plants are reliant upon soils to give water, nutrient nutrients, air exchange, and solidness. The genuine area of the soil will influence in general environment because of the scope, rise, or closeness to environment changing elements, for example, mountains or huge water bodies.

Soil natural matter alludes to the piece of the organic matter that was framed from the decayed remaining parts of dead plants and creatures. Soil natural matter fills in as the essential wellspring of

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three significant plant nutrients: nitrogen, phosphorus, and sulfur. Soil natural matter mixtures fill in as restricting specialists, which total more modest soil molecule into bigger, more steady units. Accordingly, soil natural matter is said to further develop soil structure. Soil natural matter likewise further develops maintenance of soil nutrients so they will ultimately be accessible for plant development. For instance, soils with higher natural matter levels might have better Cation Exchange Capacity (CEC), which implies that these organic matters can hold cation or emphatically charged nutrients, for example, ammonium so the ammonium can be utilized for plant development. Soil natural matter likewise builds the dampness holding limit of a organic matter. This is the reason natural revisions, for example, peat matter are so generally utilized for indoor and yard plants. Soil natural matter fills in as the food hotspot for some organic matter creatures. Natural matter influences the sustenance of forests in a few basic manners. Natural matter decay by and large fills in as the most promptly accessible wellspring of nitrogen, phosphorus, and sulfur. Natural matter expands the capacity of a organic matter to store and delivery water. Natural matter on the organic matter surface (litter layer) fills in as a pool of reused nutrients and diminishes the potential for dietary misfortunes through soil disintegration. Thusly, upkeep of natural matter is of basic significance to keeping up with forest usefulness. At last, soil natural matter fills in as a colossal supply or pool of earthly carbon that would some way or another be delivered to the air.

Soil surface influences the proportion of soil thin and non-hairlike pores. Coarser finished soils, like sands, have a higher level of thick pores so they channel effectively and don't hold as much water as a mud soil. Natural matter additionally influences a organic matter capacity to hold and delivery water. As a rule, expansions in natural matter effectively affect accessible soil water.

Local forest tree species have adjusted to site conditions more than millennia and are entirely equipped for making due without counterfeit nutrient inputs. Forests achieve this by cycling nutrients from one part of the organic matter and vegetation to one more in an intricate cycle alluded to as nutrient cycling. In a straightforward reasonable model, the woods returns leaves, branches, organic product, and dead trees to the litter layer, which at last recharges the nutrients that were removed from the organic matter. A few nutrients might be lost to the environment, some might be disintegrated, and some might be drained, however these little misfortunes are regularly renewed by information sources, for example, air affidavit or normal enduring of parent materials. In oversaw backwoods, misfortunes from the framework would likewise remember evacuation of nutrients for wood items, yet as long as just bole wood is eliminated, misfortunes are little.

Soil air circulation gives region inside the organic matter that is important for maintenance (hairlike pores) and seepage  of water. At the point when the pores are not loaded up with water they give space to the development of soil gases. This is especially significant in overflowed circumstances, where confined development of gases could permit harmful natural mixtures to aggregate. Helpless air circulation is regularly shown by plant transformations that permit them to get by under ineffectively circulated air through conditions. These specific plant structures are conventionally called pneumatophores.

Soils give trees a material where they acquire landing stage. Some tree species, because of their thick or profound establishing propensities are more steady (live oak) and a few trees, for example, the redwoods are essentially excessively monstrous such that the heaviness of the tree gives security. Be that as it may, the organic matter elements are for the most part more basic for deciding tree soundness. Trees having shallow root frameworks are intrinsically shaky and wind-toss is normal on shallow soils. This shallowness might be because of an exceptionally thick horizon, a high water table, or a shallow profundity to bed-rock. Soils that have less strength additionally favor wind-toss of trees. Decreased soil strength might be because of increment soil dampness or because of the normal shortcoming of sandy mineral soils or natural peats. Wind-toss is a typical marvels in forested wetlands, especially in spaces of high immersion and natural soils (Štursová et al., 2016).

In numerous tropical woods, environment capacities are compelled by low paces of nutrient supply When soil nutrient accessibility is diminished, biological systems show a restricted net essential creation and lower decay in the forest floor. Although in numerous spaces of the jungles mature forest is being

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changed over to auxiliary forest significantly less consideration has been centered around the ramifications of nutrient constraint to plants and biological systems in irrigated tropical regions .These woods assume a significant part in worldwide carbon elements, because of their high paces of essential creation and nutrient turnover contrasted with mature woods. (Baldrian et al., 2012) as a general rule, nutrient limit in the dry jungles is identified with water restriction since dry conditions forestall plant take-up of nutrients from the organic matter, and diminish the arrival of nutrients during deterioration. Then again, proof from low nutrient supplies for the capacity of optional tropical dry forest (TDF) environments comes from investigations of nutrient misfortunes during the exploitation of forests and from changes in soil nutrient focuses after development . As a general rule, nutrient restriction of development is corresponded with a low centralization of restricting nutrients in leaves. Since lower groupings of a nutrient in leaves show lower accessibility of that nutrient . Litterfall establishes (along with root turnover) a significant piece of nutrient cycling among plants and soils, and hence considers limitations inner motions of C, N and P at the biological system scale . The job of litter nutrients might be basic in TDF, where occasional beats of nutrients in litterfall establish a significant part of nutrient cycling

The general nutrient cycle, which includes the environment, vegetation, soil, and geography of a site, is contained two more modest cycles - the geochemical and the organic cycle. Now and again the natural cycle is further partitioned into the biochemical and the biogeochemical cycles. The biochemical cycle thinks about the interior exchanges of nutrients inside living trees and the biogeochemical cycle thinks about the exchange of nutrients between the organic matter and tree. The geochemical cycle considers the import or fare of nutrients into or out of a reserve cycles, for example, environmental affidavit by means of residue or precipitation and testimony of silt.

Trees require 20 fundamental nutrients (not positive for all species) for endurance, development, upkeep, and generation. Carbon, hydrogen, and oxygen are obtained from carbon dioxide and water. Six nutrients are needed in relative huge sums (macronutrients): nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. These macronutrients should be obtained from the organic matter. Micronutrients, or those needed in modest quantities are boron, chlorine, cobalt, copper, iron, manganese, molybdenum, silicon, sodium, vanadium, and zinc. These additionally should by and large be acquired from the organic matter. As a rule, soils are frequently restricting in nitrogen, phosphorus, or potassium, consequently these 3 components are the parts of the universes most normal inorganic manures ( Averill *et al.*, 2014).

The capacity of a specific site to give sufficient nourishment to a tree relies upon various variables and the restricting element for tree development may really differ starting with one season then onto the next. During one year precipitation might be abundant, however the organic matter nutrients can't be provided quickly enough for the tree to completely take advantage of the dampness. During the following year, dietary supplies are sufficient, yet a dry spell limits development. This sort of restricting circumstance is alluded to as Liebig's Law of the Minimum. Liebig presumed that plants will development as quickly as conceivable until some factor restricts their development. On the off chance that the restricting element is provided, another factor will ultimately become restricting. The parent material will impact the amount and enduring pace of certain fundamental nutrients

### Carbon and Nitrogen Dynamics

In many forests the significant wellspring of nutrients for trees is the course of disintegration. (Skillet et al., 2011) Decomposition alludes to the cycles that convert dead natural matter into more modest and less complex mixtures. The results of complete disintegration are carbon dioxide, water, and inorganic particles (like ammonium, nitrate, phosphate, and sulfate). Disintegration is fundamentally an organic cycle did by creepy crawlies, worms, microbes, and parasites both on the organic matter surface and in the organic matter. The pace of deterioration is impacted by many elements. Since disintegration is an organic cycle completed fundamentally carried out by microorganisms and parasites, its speed will be influenced by temperature and soil dampness ( Allison and Treseder, 2011) Generally deterioration increments dramatically with temperature; that is, for each 10 degree ascend in temperature, decay increments by a factor of 2 .Nevertheless, leaf disintegration happens at a low rate throughout the cold weather months much under profound snow Soil dampness impacts are somewhat more confounded (Vesterdal et al., 2013) Decomposition is repressed in exceptionally dry soils since microorganisms and organisms dry out. Deterioration is additionally delayed in exceptionally wet soils in light of the fact that anaerobic conditions create in immersed soils. Anaerobic deterioration is less effective than vigorous and therefore is more slow. Deterioration continues quickest at middle water substance. Trivedi et al.,2013

The nature of the leaves as a food hotspot for microbial decomposers is another significant factor. Substrate quality has been characterized from multiple points of view - as the nitrogen focus (N), as the lignin content, and as the C:N proportion. Specialists have discovered that decay of leaf litter can be anticipated by the C:N proportion, by the lignin content or by the lignin:nitrogen proportion. Essentially, excellent leaves (like nutrient rich birch leaves) will decay quicker than inferior quality leaves (like nutrient helpless conifer needles). (Machacova et al., 2016). Substrate quality can even change inside a leaf. In the underlying stages (0 to 90 days) of leaf breakdown little solvent carbon atoms, similar to starches and amino acids, are lost first leaving behind the more obstinate particles like lignin. Deterioration during this first stage is fast on the grounds that these atoms are not difficult to separate and energy rich. The second phase of disintegration - the separate of lignin - is much more slow in light of the fact that lignin comprises of extremely huge and complex particles. This quick beginning breakdown followed by a more extended time of slow disintegration brings about a mass misfortune bend that looks like a dramatic rot bend (Gauthier et al .,2015).

Nitrogen (N) is a fundamental nutrient that is exceptionally bountiful as $N_2$ in the air and furthermore as different mineral and natural structures in soils. Nonetheless, soil N bioavailability regularly restricts the net essential efficiency of unperturbed calm forests with low climatic N input. This is on the grounds that most soil N is important for polymeric natural matter, which requires microbial depolymerization and mineralization to deliver the bio availability of N structures, for example, monomeric natural or mineral N. In spite of this N constraint, numerous unfertilized woods environments on negligible soil show moderately high usefulness and N take-up tantamount to agrarian frameworks. The current framework resolves the topic of how this high N request is met in mild woods biological systems. For this reason, current information on the dispersion and motions of N in minor forest soil and the guideline of N securing and appropriation in trees are summed up. The connected cycles and transitions under N limit are contrasted with those of backwoods uncovered with high N loads, where persistent environmental N testimony has calmed N limit and caused N immersion. We reason that organic matter microbial biomass is of conclusive significance for nutrient maintenance and arrangement to trees both in high and low N environments.

The high N interest of calm forest environments on peripheral soil depends only on biological system inner sources. In this specific situation, free-living soil microorganisms are answerable for both nutrient freedom and rivalry against trees and their related mycorrhizal dependency. Inward biological system microbial N mineralization-immobilization turnover surpasses plant-intervened inside environment N-cycling circles by around one significant degree. Subsequently, the organic matter microbial biomass addresses a potential plant nutrient repository of impressive significance, and there is expanding proof that mild backwoods trees apply an immediate impact on the accessibility of microbial-headed N for plant take-up. Constant climatic N statement eases N impediment and microbial contest for N, bringing about mineral N gathering in soil and environment N misfortunes along hydrological and vaporous pathways in the scope of the N input rates. Nonetheless, microbial N maintenance to a great extent overwhelms over N misfortune and stays a significant pathway of nutrient maintenance in N-soaked forest biological systems. Diminished microbial rivalry for ammonium can bring about trees taking up ammonium instead of nitrate.

While our comprehension of the guideline of N take-up and dissemination in trees has improved, an exhaustive biogeochemical evaluation and comprehension of soil microbial freedom, turnover and take-up of bioavailable N has hitherto just been accomplished for not many forest environments and in this manner merits further consideration to acquire a superior comprehension of the N cycling designs in the plant-soil-microorganism arrangement of calm backwoods under an evolving environment.

The relationship among plant measures and microbial cycles and the impacts of these cycles on plant diversity of late been investigated through models. The model accentuates the natural and biochemical soil-plant subsystem, including plants, microorganisms, natural deposits, and mineral N. Temperature and dampness are driving factors. Many factors like nitrification, root take-up of inorganic N, mineralization, immobilization, and humification. Growth factors for plant development, phenology, plant reaction to N supply and N rearrangement during development and senescence are adequately unthinking with the goal that the essential maker submodel can give substrates to the decay part of the model. The medicines of denitrification and draining are oversimplified, and natural nitrogen obsession is incorporated with an overall environmental information work. Smelling salts volatilization is excluded, nor is non-interchangeable alkali obsession by organic matters.

## Carbon and Phosphorus Dynamics

The immobilization, mineralization, and rearrangement of P forms basics of P cycling in soils . The fundamental wellspring of P in soils is from essential P minerals basically hydroxyapatite. This material is sparingly solvent and deliveries modest quantities of phosphate to arrangement, where it enters in harmony with labile inorganic P (Pi). Auxiliary Pi mixtures of diminished solvency and impeded types of Pi may likewise be available, particularly in more endured soils.

P in arrangement might be taken up by plant roots or by microbes and parasites. Microorganisms contribute towards mineralization of P, which adjusts ensuing reallocation of natural P (Po) in soil. Mineralization paces of Po rely upon the accessibility of arrangement P to the microbial populations in light of the fact that the C:P proportion of the microorganisms and contagious biomass impacts mineralization rates . Both the accessibility of P from arrangement and the measure of energy accessible for microbial development impact the piece of the bacterial and contagious cells and furthermore their resulting rearrangement in soil. The C:P proportion in the organic matter biomass was enormous (45:1 to 60:1), and with expansion of cellulose the inventory of P restricted the microbial decay of the cellulose (van der Heijden et al., 2015).

These examinations give us some understanding into the conceivable reallocation of P in soils. Studies did in microcosms in which blends of single bacterial, amoebal, and nematode species were added to cleaned soils within the sight of an energy source additionally have given knowledge into the organic changes of Po in soils and into the abiotic impacts, like freezing and defrosting (Peršoh, 2015).

## Carbon and Sulfur Dynamics

Sulfur, a constituent of amino acids and co-factors, is fundamental for the design and metabolic activity of every living cell. Not at all like C and N, S can be used somewhat in its most profoundly oxidized, normally happening structure, $SO_4^{2-}$. Overall notwithstanding, plants and miniature creatures decrease sulfate to S(- II) and utilize this to shape S-containing amino acids and other diminished S compounds needed for their reality. Higher creatures use these diminished natural mixtures, after which they are changed to the first inorganic mixtures, an interaction that happens to fluctuating degree in all organic entities (Chas et al., 1986).

## Conclusion

The nutrient interest of forest environments on peripheral soil depends solely on biological system inside sources. In this unique situation, free-living soil microorganisms are answerable for both nutrient freedom and rivalry against trees and their related mycorrhizal dependency. Inner biological system microbial nutrient mineralization-immobilization turnover surpasses plant-intervened environment nutrient cycling by significantly. In this way, the organic matter microbial biomass addresses a potential plant nutrient repository of impressive significance, and there is expanding proof that forest trees apply an immediate impact on the accessibility of microbial-headed nutrient for plant take-up.

While our comprehension of the guideline of nutrient take-up and dissemination in trees has improved, a careful biogeochemical measurement and comprehension of soil microbial freedom, turnover and utilization of bioavailable nutrient has so far just been accomplished for not very many forest environments and consequently merits further consideration to acquire a superior comprehension of the nutrient cycling designs in the plant-soil-organism arrangement of forests under an evolving environmental scenario.

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