*Mapana Journal of Sciences*

2019, Vol. 18, No. 4, 1-8

ISSN 0975-3303 | <https://doi.org/10.12723/mjs.51.1>

# Impact of Cropping Systems on Soil Microbial Load: Evidence from Wetland Ecosystems of Wayanad District, Kerala

P Asiya\*, Manjula Menon†, Girigan Gopi‡ and Vipin Das§

## Abstract

This study enumerated the microbial communities in soil samples from rice, banana and arecanut from the wet lands of Wayanad district Kerala. The total viable bacterial count in the paddy field was  $120 \times 10^6$  cfu,  $121 \times 10^6$  cfu and  $147 \times 10^6$  cfu in Nenmeni, Kaniyambatta and Pozhuthana Gramapanchayat and that of fungi was  $30 \times 10^3$  cfu,  $32 \times 10^3$  cfu and  $37 \times 10^3$  cfu. Likewise, the total viable count of bacteria in areca nut at Nenmeni, Kaniyambatta and Pozhuthana Gramapanchayat was  $66 \times 10^6$  cfu,  $80 \times 10^6$  cfu,  $118 \times 10^6$  cfu and that of fungi was  $14 \times 10^3$  cfu,  $18 \times 10^3$  cfu, and  $30 \times 10^3$  cfu. The total viable count of bacteria in banana field at Nenmeni, and Pozhuthana was  $51 \times 10^6$  cfu and that of Kaniyambatta Gramapanchayath was  $56 \times 10^6$  cfu. The viable fungal colony at Nenmeni and Kaniyambatta was  $18 \times 10^3$  cfu and that of Pozhuthana Gramapanchayath was  $24 \times 10^6$  cfu.

**Keywords:** Bacteria, Fungi, cfu

## 1. Introduction

Wetlands are ecologically as well as economically important systems due to their high productivity, nutrient recycling

---

\*Community Agrobiodiversity Centre (CAbC), MS Swaminathan Research Foundation(MSSRF), Wayanad, Kerala, India; [pasiya81@gmail.com](mailto:pasiya81@gmail.com)

† (CAbC), (MSSRF), Wayanad, Kerala, India; [manjulamenon@gmail.com](mailto:manjulamenon@gmail.com)

‡ (CAbC), (MSSRF), Wayanad, Kerala, India; [girigangopi@gmail.com](mailto:girigangopi@gmail.com)

§ (CAbC), (MSSRF), Wayanad, Kerala, India; [vipindaskbd@gmail.com](mailto:vipindaskbd@gmail.com)

capacities, and their prominent contribution to global green-house gas emissions. Being on the transition between terrestrial and aquatic ecosystems, wetlands are buffers for terrestrial run off thereby preventing eutrophication of inland [1]. The close proximity of oxic–anoxic conditions, often created by wetland plant roots, facilitates the simultaneous activity of aerobic as well as anaerobic microbial communities. Input of nutrients and fast recycling due to active aerobes and anaerobes makes these systems highly productive and therefore attractive for humans as well as many other organisms. Wetlands globally are under high pressure due to anthropogenic activities as well as climate change. Changes of land-use as well as altered hydrology due to climate change will lead to disturbance and loss of these habitats [1]. However, the diversity and functioning of microbial communities in wetland systems is highly underexplored in comparison to soils and aquatic ecosystems [1].

Knowledge of microbial diversity and functions in soil is limited because of the taxonomic and methodological limitations associated with studying these microorganisms [2]. It is important to study microbial diversity not only for basic scientific research, but also to understand the link between microbial diversity and community structure and function. Soil bacteria and fungi play pivotal roles in various biogeochemical cycles [3,4,5]. Soil microorganisms also influence above ground level ecosystems by contributing to plant nutrition [6,7], plant health [8] soil structure [9] and soil fertility [10].

There are a number of potential advantages for using microbes as bioindicators. Firstly, microbial populations can undergo rapid changes in composition and function in response to changing environmental conditions. Secondly, bacteria are extremely sensitive to even small fluxes of contaminants in the environment. Indeed, monitoring of aerobic bacterial metabolic diversity has been suggested as a means to detect the early signs of degradation in wetland ecosystems [11]. In order to overcome the challenges associated with microbial indicators (such as temporal population changes and accurate identification of microbes), the design of assessment strategies should be matched to the hydric soil characteristics in wetlands. Thus, rather than monitoring the global

microbial population, it is important to determine soil microbial communities that are heavily involved in wetland biogeochemical cycles.

In Kerala the issue of paddy conversion is complex and it involves economic, ecological, socio-cultural, and structural and class dimensions. Paddy conversion implies abandoning a highly developed and complex wetland agro ecosystem which involves the irreversible transformation of the ecosystem [12]. The landowners of the paddy fields convert their fields for other crops and non-agricultural purposes because the economic return from paddy cultivation is not attractive to induce conservation. Land owners, mostly, the non-full time farmers argue for the freedom of individual choice to shift away from paddy for profit maximisation. Therefore, to ensure adequate return, it seems that they have accepted inevitable conversion [13]. Even though Kerala ranks top in literacy and environmental awareness, wetland area under paddy in the last 50 years has declined to 65 percent. From covering 40,000 hectares in the 1960s, paddy fields today cover merely 8,000-13,000 hectares in the region. Total abandonment of rice cultivation in near future would be due to the continuation of unabated massive conversion. In this context a study was conducted to enumerate the microbial load, especially the fungal and bacterial load, in three cropping systems in wetlands of three agro climatic regions of Wayanad district of Kerala.

## 2. Methodology

The study was carried out in Wayanad district of Kerala. The study locations were three panchayats which lies in three different agroclimatic regions of Wayanad, namely, Nenmeni, Kaniyambatta and Pozhuthana. In the geographic location, these lie between the latitudes of N-11033'28.4 and N-11048'33.2 and longitudes of E-075059'19.1" and E- 076012'31.0".

### 2.1 Sampling of soil

The soil samples used for this work were collected from three panchayats of Wayanad, namely, Nenmeni, Kaniyambatta and Pozhuthana. The samples were collected before the onset of Monsoon from three different cropping system, namely, paddy,

banana and areca nut, and from wetlands after getting few summer showers. The samples were collected in sterile glass bottles and were labeled properly. 250 grams of soil sample was randomly collected from each plot and was mixed well. The samples were transported in sterile glass bottles in ice pack to the laboratory. When samples could not process immediately, they were stored at 4°C for no longer than 18 to 24 h.

## 2.2 Sterilisation techniques

The glass bottles for sample collection, growth media, and diluents (distilled water) and glass wares were autoclaved at 121°C for 15 min.

## 2.3 Microbiological analyses

Each soil sample was mixed, and a suspension of 1 g (dry weight equivalent) in 10 ml of sterile water was prepared. One ml of the soil suspension was then diluted serially (ten-fold) and used in the estimation of bacterial and fungal populations by standard spread-plate dilution method described by Seeley and VanDemark [14], in triplicate. Nutrient agar (M001 Himedia chemicals) and added 0.015% (w/v) nystatin (to inhibit fungi growth) was used for bacteria isolation and incubation was done at 28°C for 24 hrs. Potato dextrose agar (M096) to which 0.05% (w/v) chloramphenicol was added (to inhibit bacteria growth) and used for fungal isolation, and incubation was done at 30°C for seven days. The colony forming unit was recorded by using a colony counter. The pure culture of the isolates was maintained for further studies in glycerol stock and in agar slants at 4°C.

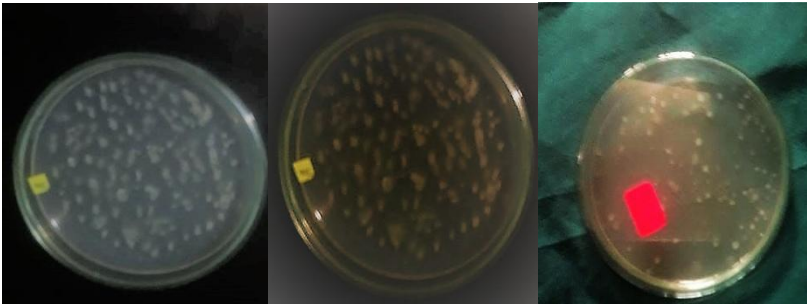
## 3. Results and Discussions

Microbiological results: Marked effects were found to have taken place on the bacterial population under different wetland cropping systems. This was clearly demonstrated by the total number of bacterial colonies forming unit (CFU) recorded from the nutrient agar plates. The maximum number of bacterial colony were recorded from the paddy cultivating wetlands in all the three panchayats, highest CFU with  $147 \times 10^{-6}$ , followed by  $121 \times 10^{-6}$ ,  $120 \times 10^{-6}$  Pozhuthana, Kaniyambatta and Nenemeni panchayat

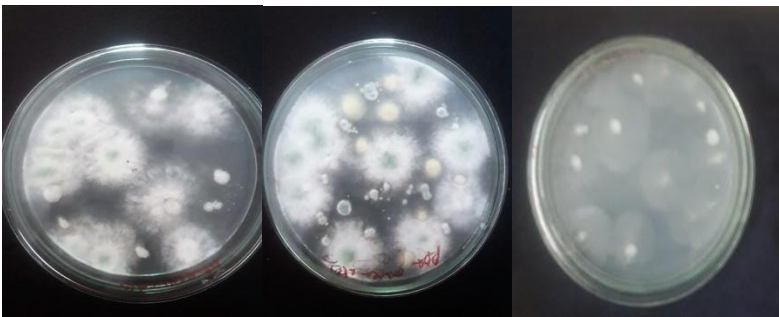
respectively. The bacterial colony in banana was the highest in Kaniyambatta panchayat with  $56 \times 10^6$  and that of Nenmeni and Pozhuthana with  $51 \times 10^6$ . Likewise, in arecanut the highest was in Pozhuthana with  $118 \times 10^6$ ,  $80 \times 10^6$ ,  $66 \times 10^6$  in Kaniyambatta and Nenmeni respectively. The fungal colony abundance was highest in the rice-based cropping system with  $37 \times 10^3$  and least with  $30 \times 10^3$  CFU/gm of soil in Pozhuthana and Nenmeni panchayat respectively. In banana cultivating wetland it was highest in Pozhuthana with  $24 \times 10^3$  and  $18 \times 10^3$  each in Kaniyambatta and Nenmeni. The fungal abundance in arecanut was high in Pozhuthana panchayat with  $30 \times 10^3$ ,  $18 \times 10^3$  and  $14 \times 10^3$  in Kaniyambatta and Nenmeni panchayats respectively. The decrease in the microbial population could be due to the use of the pesticide and chemical fertilizers in the banana and areca nut cropping systems when compared to the paddy cultivation in the wetland. The paddy cultivation is mainly done organically by adopting the traditional cultivation practices by applying cowdung and green manure and by sowing the cow pea as a method of crop rotation to ensure the availability of the nitrogen in soil. The results are shown in Table 1, figure 1, 2 and plate 1.

**Table 1:** The results of number of culturable bacterial and fungal isolates from different wetland-based cropping systems in three panchayats

Study location	No of Bacterial colonies ( $10^6$ ) dilution			No of Fungal colonies ( $10^3$ ) dilution		
	Crops					
	Banana	Areca nut	Paddy	Banana	Areca nut	Paddy
Nenmeni	51	66	120	18	14	30
Kaniyambatta	56	80	121	18	18	32
Pozhuthana	51	118	147	24	30	37



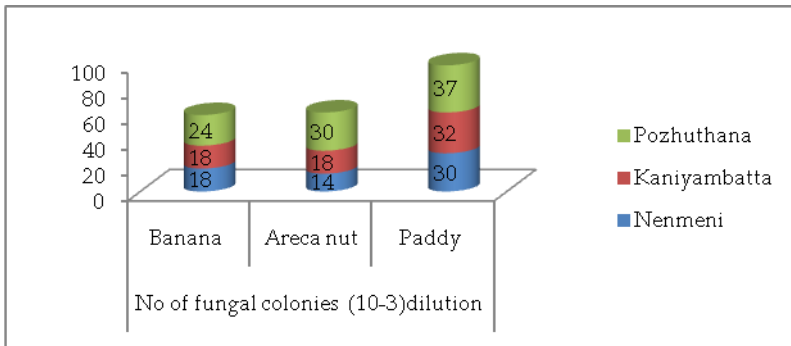
**Plate 1:** Photograph of the incubated plates of Bacteria and Fungi



**Plate 2:** Bacterial colony in a) areca nut field b) paddy field c) banana field @ $10^{-6}$  dilution



**Figure 1:** Fungal colony in a)areca nut field, b) Paddy field and c) Banana field @ $10^{-3}$  dilution



**Figure 2:** Graphical representation of number of culturable fungal isolates in three cropping systems in three Gramapanchayath

It was clearly evident from the above primary soil microbial analysis data that the shift in cropping pattern will affect the bacterial and fungal diversity in wetland. Further studies have to be conducted to determine the role of isolated bacteria and fungi as plant growth promoters as well as plant disease suppressers.

#### 4. Acknowledgments

The researcher would like to thank M. S. Swaminathan, Research Foundation Chennai , M. S. Swaminathan, Research Foundation Community Agro Biodiversity Center Kalpetta and South Asian Network for Development of Environmental and Economics (SANDEE) for giving facilities and for funding the research.

#### References

- [1] Bodelier, Paul and Dedysh, Svetlana. "Microbiology of wetlands. *Frontiers in microbiology*."4. 79. 10.3389/fmicb.2013.00079. 2013.
- [2] J.L Kirk, L.A Beaudette, M. Hart, P. Moutoglis, J. N. Kliromonas, H. Lee and J.T Trevors. "Methods of studying soil microbial diversity" *J.Microbiol. Methos*,58:169-188. 2004.
- [3] J Molin and S. Molin. "CASE:Complex adaptive systems ecology",*In: Advances in Microbial ecology*", Jones, JG (ed.).Vol.15, plenum, Newyork, pp:27-79. 1997.
- [4] J.T Trevors. "Bacterial biodiversity in soil with an emphasis on chemically contaminated soil", *Journal of Water air soil pollut.*, 101:45-67.1998.
- [5] D.H Wall and R.A. Virginia. "Controls on soil biodiversity: insights from extreme environments", *Applied Soil Ecol.*, 13:137-150. 1999.

- [6] E. H George, Marschner and I Jacobson. "Role of AMF in uptake of P and N from the soil", *Crit.Rev.Biotechnol.*,15:257-270.1995.
- [7] S.Timeson, R.D. Finlay, Soisson and B.Soderstorm, "Dynamics of Phosphorus translocation in intact ectomycorrhizal systems:Non destructive monitoring using a B scanner FEMA". *Microbiol. ecol*, 19:171-180 1996.
- [8] D.R Srivasthava, S.K Kappor, Srivasthava and K.G Mukherji. "VAM: an overview. In: *Concepts in Mycorrhizal Research*", Mukherji, K.G.(Ed.). Kluwer Academic Publishers , Netherlands ,pp:1-39. 1996.
- [9] J.C Dodd, A. Boddington, C. Rodriguez, Gonazalez Chavez and I. Mansur. "Mycelium of AMF from different genera:form function and detection", *Plant Soils*, 226:131-151.2000.
- [10] A.G.O Dinnel, M. Seasman, A. Macrae, I. Waite and JT Davis. "Plants and fertilizers as drivers of change in microbial community structure and function in soils". *Plant Soils*, 232:135-145.2001.
- [11] M. Merkley, R. P. S George and C. Mukherjee. "Rice economy of Kerala : A disaggregated analysis of performance ",*Indian journal of Agricultural economics*, Vol-4No 1. Rader J. McArthur, D. Eggett. "Bacteria as bioindicators in wetlands: bioassessment in the Bonneville basin of Utah, USA. *Wetlands*", 24 (3), 600-607. 2004.
- [12] F. Agus and A. Mulyani. "Judicious use of land resource for sustaining Indonesian rice self-Sufficiency". Presented at international Rice conference pp 12-14 September 2005.
- [13] P.S George and C. Mukherjee. "Rice economy of Kerala: A disaggregated analysis of performance", *Indian journal of Agricultural Economics*, Vol -4, No 1.
- [14] Seeley, H.W. Van Demark P.J. "Microbes in action. A laboratory manual of Microbiology". 3rd Edition. W.H Freeman and Company U.S.A p. 350. 1981.