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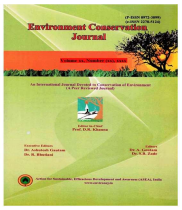

# Developing nation's soil microbial community shifts and diversity loss: leading towards major ecological threat

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**ABSTRACT**

**Nature does not discriminate and has no boundaries; however only developing nations faces huge food security issues and in such circumstances much of importance has been emphasised on food production technologies but studies and research on concealed factor behind food production i.e biogeochemical drivers were largely overlooked. Injudicious agricultural practices; for instance profound use of agrochemicals in continuous and unmonitored way may had already situate many soil microbial species in verge of extinction consequently creating ecological imbalance. With huge land pressure for crop production and lack of upto date technologies of preciseness, most of the developing nation which includes the whole of Africa, almost all Asian countries and numerous other island states faces the agricultural land degradation issues; one of the major reason for such degradation is missing out of ecological drivers i.e soil microbial diversity. Anthropogenic activities application of fertilisers, land use changes (LUC), land intensification, crop diversification, irrigation management etc accelerates the soil microbial community shifts and microbial diversity loss predominately in developing nations. In this short communication, we address the concerns faced by the developing nations to prevent the soil microbial community shift and diversity loss. Also we propose the each exported commodity may have specific tax included which may be utilised by soil scientist from developing nations for studying the current soil microbial shifts and diversity loss due to agriculture management practices more efficiently.**

## Introduction

Soil microbial biochemical driver extinctions may largely infer sustainability of Earth's ecosystem (Hooper *et al.,* 2012). Green revolution has been initiate in year 1960s and worked very well in relation to ensure food security; however at the current stage, generations are facing the darker shades of green revolution (Nelson *et al.,* 2019). Some of the most successful intervention in terms of crop productivity deviated from natural ecological laws and gradually drag the current generation to unsustainability (Kumar *et al.,* 2020, John and Babu 2021) ; further to avoid any ecological consequences, soil scientist need to work on the basics of ecosystem, i.e. soil microbial population and its diversity. Most of the lands become infertile, ground water unavailability and toxicity, and most importantly lack of knowledge about fertilisers and their long term impact on soil microbial communities. Soil microbial diversity loss were mostly accelerated by anthropogenic means. Impacting component may be usage of organic and inorganic fertilisers, land use changes, agriculture land intensification, crop diversification, climate change, irrigation management, industrial discharges and many more (Yang *et al.,* 2021). Soil scientist has major challenges which includes

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identification of the authenticated soil health indicator which represent the veracious picture of the soil; precise evaluation of microbial diversity loss through human induced global change factors (Zhou *et al.,* 2020), categorisation and characterisation of microbial communities with reference to their habitat mineralogy and substrate biology, implication of noble technologies like soil nano-material application on soil microbial diversity etc; for such research timely funding is very crucial factor for preserving soil microbial diversity.

**Injudicious use of fertilisers and pesticides: Microbial Community Shift and Diversity Loss**

In developing nations like India, lack of knowledge on fertiliser impact on soil health is extremely challenging concern. India having merely 2.4% of the world's total land area yet support 18% world population (Hinz *et al.,* 2020); which implies the intensive and extensive use of agriculture land and the land pressure is huge for productivity. In such scenario, mineral fertiliser usage has been intensified in recent years to achieve higher productivity (Fig1); consequently led to inferior soil health and soil degradation (Gautam *et al.,* 2020). Soil degradation is majorly due to microorganism microhabitat toxicity which is result of excessive fertiliser application; Soil microbial community structure is the indicator to analyse and identify the microbial groups on verge of death or loss completely from community structure in any land use system. Excessive mineral fertilisers not only create soil toxicity, also interfere with soil pH; a crucial parameter associated with microbial community structure. Studies has proven that long term amendments of chemical fertilisers reduce bacterial community composition; indicates microbial diversity loss from an ecosystem (Wu *et al.,* 2020). Most of such studies are carried out only in developed nations; however in developing nations like India which support most life via crop production lacks the funds for such molecular level studies consequently no clear interpretation of soil health and microbial diversity can be drawn at this stage. Not only fertilisers are the culprits; herbicides and pesticides are also damaging the soil microbial health, may be interfering with specific uncultivable microorganism which the scientific community unaware of. Pesticides may have depressive impact of microorganism (Lo 2010); or it may modify the microbial community structure. Developing nations where lands are extensively used for agriculture, pesticides are the major component and need to be assessed for its impact of soil microbial health. The darker shades of green revolution is inevitable in developing nations where fertilisers are intensively used for higher crop productivity; however according to studies merely 10%-40% of nutrients are used by the crops (Bai *et al.,* 2020) and remaining fertilisers concentration in soil over the period of time and further leaching, impacts the soil microbial community structure; it is very much clear that most of the microbial species in loop of soil microbial community structure will be disturbed. However to evaluate the magnitude of such change molecular tools are required; critically in developing most funds were dedicated to crop research and to enhance crop productivity; only a minute funds were generally allocated to study the impact of injudicious fertilisers on soil microbial health; consequently we evident very few reports on soil microbial community structure and diversity loss. On other hand developped nations implement precise plant nutrient management strategies and evaluate their agriculture soil health and soil microbial status more efficiently (Rahman and Zhang, 2018).

**Land use change impact soil microbial community shifts and diversity loss**

Developing nations agriculture has many challenges to meet the food demand **(**Pingali 2012), during this race for food demand long term impact like microbial species extensions were overlooked. Imitating natural soil microbial community structure becomes very tedious once altered by anthropogenic activities. Recent studies suggest that maintaining the microbial diversity while altering land use change is necessary to sustain normal ecosystem functions (Sui *et al.,* 2019); however the basic fundamental microbial species insight and further interpretation due to land use changes were questioned. The meta-genomics studies revealed that season and land use changes impacts the microbial structure composition and soil functions (Lacerda-Júnior *et al.,* 2019); developing nations need to access such changes immediately; else key ecological microbial drivers may missed out from system and we will not be able to restore them. Land use pattern change initiates the chemical property change, in turn the

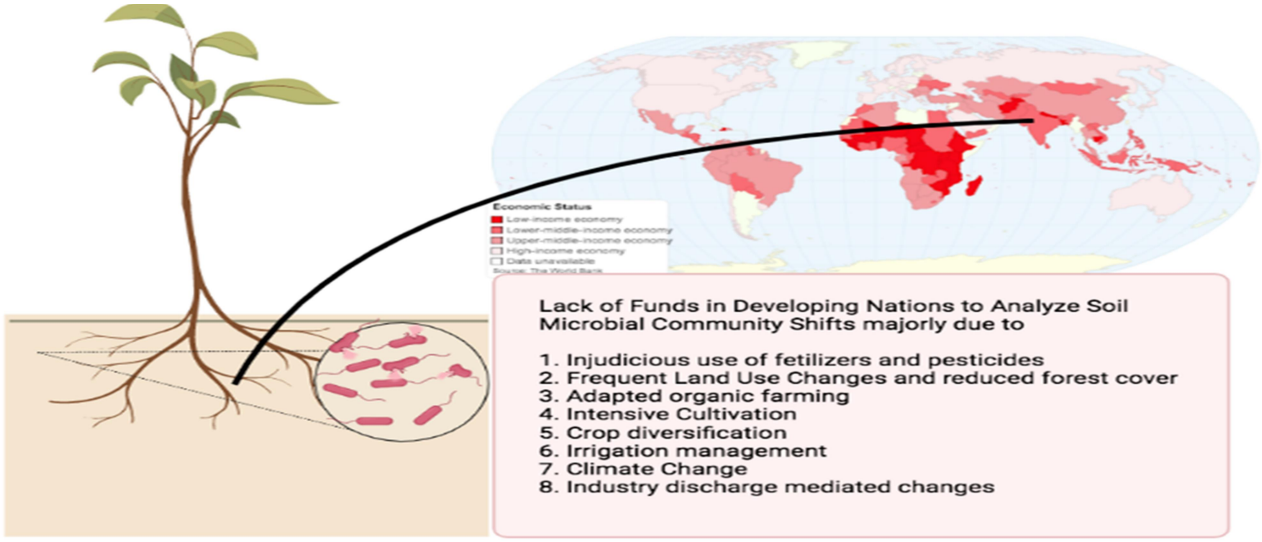


**Figure 1: Important reasons for soil microbial community structure shifts and diversity loss that need to be assessed on urgent basis. (Created with biorender)**

microbial community shift occurs impacting the natural ecosystem functioning (Wu *et al.,* 2020). For instance during 1947 India has the forest cover of 49% and currently in year 2021, forest cover is only 21.67 percent; indicates huge degradation of land resources, consequently huge diversity loss. Further non assessment of life supporting system in developing nations is threat to mankind.

**Organic farming and soil microbial community shifts**

Long term organic farming practices improves soil nutrient mobility and enhance species richness (Liao *et al.,* 2018); however very limited studies has been documented on soil microbial community shifts due to organic amendments to soils; almost no such studies are documented from developing nation with meta genomics analysis. Though several studies report positive impact of organic farming on soil microbial abundance; no systematic interpretation on microbial community structure shift were presented from developing nations which need to be assessed to maintain environmental sustainability (Lori *et al.,* 2017). In the current scenario of unproductively, organic farming is recommended to improve soil health and enhance microbial richness (Acharya *et al.,* 2020); however such recommended is partially biased as it doesn't interpret and insight the actual microbial species shift. In both organic and conventional farming systems microbial community shift occurs (Yang *et al.,* 2020); to evaluate such change, molecular biology soil research is required, then only soil scientist may able to analyse, interpret and recommend the impeccable management strategy with minimal disturbance to natural soil microbial community.

**Intensive cultivation and crop diversification: Soil microbial community shift**

Soil microbial community structure majorly is the consequence of crop rhizosphere, organic matter, climatic conditions; once established they perform soil function in harmony with each other. Studies proves that in both conditions conventional or organic management practices determines the rhizosphere microbial community compositions (Schmidt *et al.,* 2019). The quality of organic matter determines the soil microbial ecological drivers which takes part in biogeochemical reactions and studies shows that such carbons are strongly related to microbial community structure and its function (Murphy *et al.,* 2011). So the crop diversification and subsequent organic matter selection need to be tested for reduction in microbial community shifts and microbial diversity loss; no such research has been documented in recent years from developing nations. Intensive agriculture coupled with random crop diversification may seriously impact ecosystem diversity. Although in most cases increasing plant diversity in agricultural systems enhances soil

microbial diversity, but crop and microbial species interaction is very complex communication and till date poorly understood (Stefan *et al.,* 2021).

**Climate change and pollution: soil microbial community shifts and diversity loss.**

Climate, a very much stable component and takes part in designing the nature's biodiversity; has been changed during last century and average global temperature raised by 1.5 °F (Dutta and Dutta 2016). Such huge change undoubtably have impacted the soil microbial diversity and at this critical stage such change need to be assessed immediately. Future climate change aspects predicts the increase in carbon-dioxide concentration; will definitely have indirect impacts on soil microbial community structure and functions (Deltedesco *et al.,* 2020). At the verge of many microbial species extension, limited studies are confined to stability of microbial communities (De Vries and Shade 2013) which may have indirect consequences and impact ecological functions. Threats to biodiversity has been accelerated due to global change factors, mostly anthropogenic (Zhou *et al.,* 2020). And our understanding for below growth microbial communities shifts due to climate is still limited and worst part is even fewer studies were documented in relation to climate change and soil microbial diversity in developing nations. Besides the climate change issue, below ground microbial diversity faces toxicity via industrial discharges which are not properly managed by most of the industries.

## Conclusion

According to IMF world data (https://www.worlddata.info/developing-countries.php) nearly 85% of world population belongs to Developing Nations and huge area of agriculture pertains to developing nations. However most of the soil microbial community shift or microbial diversity loss studies were only confined to well develop nations. There is an immediate need to evaluate agrochemical impacts and land use change on soil microbial communities; for such life sustaining concern developed nations need to support developing nations via new funding scheme, policy decisions, increasing collaborative research precisely for understand soil microbial diversity loss. We also propose the every exported commodity from developing nations should come with research tax that may be utilised for maintaining environmental sustainability.

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