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IMPACT OF ORGANIC FARMING ON SOIL BIODIVERSITY

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ABSTRACT

Massive soil destruction has taken place worldwide and also in Sri Lanka in the name of intensive agriculture over a considerable period of time. Soil biodiversity has been under threat as a result of the soil degradation. Our experience over the last three decades has shown that soil health is deteriorating. This is due to attempts at pure economic development at the expense of natural resources, thereby resulting in unlimited environmental degradation. If this continues without any limitation, land and life in it might die? A set of activities should be accomplished to conserve the soil biodiversity. Organic farming is one among those activities that are supportive of the soil. We present this paper with the aim of conservation of soil biodiversity through the organic farming practices. Benefits of organic management on soil biological diversity and activity are briefly explained in the paper and also the environmental benefits are elaborated.

INTRODUCTION

Organic farming is a production system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives. To the maximum extent feasible, organic farming systems rely upon crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, mechanical cultivation, mineral-bearing rocks and aspects of biological pest control to maintain soil productivity and yield to supply plant nutrients and to control insects, weeds and other pests.

Organic farming is the form of agriculture that relies on crop rotation, green manure, compost, biological pest control, and mechanical cultivation *etc.* to maintain soil productivity and control pests, excluding or strictly limiting the use of synthetic fertilizers and synthetic pesticides, plant growth regulators, livestock feed additives, and genetically modified organisms (Lotter,2003). However, there are various definitions for organic agriculture and there are many arguments on it.

The term "conventional farming" will be used to refer the production system which employs a full range of pre- and post-plant tillage practices (*e.g.*, plow, disk, plant, cultivate), synthetic fertilizers and pesticides. Conventional farming is characterized by a high degree of crop specialization. By contrast, organic farming is characterized by a diversity of crops. Organic agriculture is based on four factors named as principal of health, principal of ecology, principal of fairness and principal of care *(IFOAM, 2005).*

Many changes observed in the environment are long term, occurring slowly over time. Organic farming considers the medium and long term effect of agricultural interventions on the agro ecosystem. It aims to produce food while establishing an ecological balance to prevent soil fertility or pest problems. Organic farming takes a proactive approach as opposed to treating problems after they emerge.

The paper aims to explore the following, the impact of organic farming on soil biodiversity.

SPECIFIC OBJECTIVES

(1) Identification of the benefit of soil biological activities which enhances the soil biodiversity.

(2) Identification of soil biodiversity benefits with special focus on organic manage field.

(3) Examine environmental benefits of the organic farming.

Soils contain enormous numbers of diverse living organisms assembled in complex and varied communities. Soil Biodiversity reflects the variability among living organisms in the soil ranging from the number of invisible microbes such as bacteria, fungi and soil and more familiar macro faunas like earthworms and termites. Plant roots can also be considered as part of soil biomass in view of their symbiotic relationships and interactions with other soil biotic components. These diverse organisms interact with one another and with plants and animals in the ecosystem, forming a complex web of biological activity. Environmental factors, such as temperature, moisture and P^H as well as anthropogenic actions, in particular, agricultural and forestry management practices, affect, to different extents, soil biological communities and their functions.

Soil organisms contribute a wide range of essential services to the sustainable functioning of all ecosystems. They act as the primary driving agents of nutrient cycling, regulating the dynamics of soil organic matter, soil carbon sequestration and greenhouse gas emissions; modifying soil physical structure and water regimes, enhancing the amount and efficiency of nutrient acquisition by the vegetation and enhancing plant health. These services are not only critical to the functioning of natural ecosystems but constitute an important resource for sustainable agricultural systems.

IMPORTANCE OF SOIL BIOLOGICAL ACTIVITIES

Benefits of soil biological activity for agricultural production requires the following ecological principles.

Supply of organic matter

Each type of soil organism occupies a different niche in the web of life and favors a different substrate and nutrient source. Most soil organisms rely on organic matter for food, thus a rich supply and varied source of organic matter will generally support a wider variety of organisms.

Increased plant diversity

Crops should be mixed and their spatial and temporal distribution varied, to create a greater diversity of niches and resources that stimulate soil biodiversity. For example diverse habitats support complex mixes of soil organisms, and through crop rotation or inter-cropping, it is possible to encourage the presence of a wider variety of organisms to improve nutrient cycling and natural processes of pest and disease control.

Protecting the habitat of soil organisms

The activity of soil biodiversity can be stimulated by improving soil living conditions, such as aeration, temperature, moisture, and nutrient quantity and quality. In this regard, reduced soil tillage and minimized compaction and reducing synthesized artificial chemical used to conserve the habitat of soil organisms.
Improvement in agricultural sustainability requires, alongside effective water and crop management, the optimal use and management of soil fertility and soil physical properties. Both rely on soil biological processes and soil biodiversity. This calls for the widespread adoption of management practices that enhance soil biological activity and thereby build up long term soil productivity and health.

Adaptation and further development of soil biodiversity management into sustainable land management practices require solutions that pay adequate consideration to the synergies between the soil ecosystem and its productive capacity and agro ecosystem health. One practical example of holistic agricultural management systems that promote and enhance agro ecosystem health, including biodiversity, biological cycles and soil biological activity is organic farming.

Organic farming significantly increases the density and species richness of soil's life. Suitable conditions for soil fauna and flora as well as soil forming and conditioning and nutrient cycling are encouraged by organic practices such as manipulation of crop rotations and strip cropping, green manuring, manure and organic fertilization (animal manure, compost, crop residues) minimum tillage and, of course, avoidance of pesticide and weedicide use.

Benefits of organic management on soil biological diversity and activity are summarized below.

Abundant Arthropods and Earthworms.

Organic farming practices increase the abundance and species richness of beneficial arthropods living aboveground and earthworms and thus improves the growth conditions of crops. More abundant predators help to control harmful organisms (pests). In organic systems the density and abundance of arthropods, as compared to conventional systems, have up to 100% more carabids, 60-70% more staphylinids and 70-120% more spiders. This difference is explained by prey deficiency due to pesticide influence as well as by a richer weed flora in the standing crop that is less dense than in conventional plots. The biomass of earthworms in organic systems is 30-40% higher than the conventional systems, their density even 50-80% higher. Compared to the mineral fertilizer system, this difference is even more pronounced.

High occurrence of symbiosis

Organic crops profit from root symbioses and are better able to exploit the soil. On average, mycorrhizal colonization of roots is highest in crops of unfertilized systems followed by organic systems. Conventional crops have colonization levels that are 30% lower and the nutrients absorbed directly from the soil. The most intense mycorrhizal root colonization is found in grass clover, followed by the vetch rye intercrop (Jannee Bengtsson 2005). Roots of winter wheat are scarcely colonized. Even when all soils are inoculated with active micorrhizae, colonization is enhanced in organic soil. This indicates that, even at inoculums in surplus, soil nutrients at elevated levels and plant protection suppress symbiosis. This underlines the importance of appropriate living conditions for specific organisms.

High densities of micro-organisms

Earthworms, fungi, bacteria, and numerous other microorganisms are in the soil. In organically managed soils, the activity of these organisms is higher. Micro organisms in organic soils not only mineralize more actively but also contribute to the build up of stable soil organic matter. Thus, nutrients are recycled faster and soil structure is improved. The amount of microbial biomass and decomposition is connected, at high microbial biomass levels little light fraction material remains un-decomposed and *vice versa*.

Increased microbial carbon

The total mass of micro organisms in organic systems is 20-40% higher than in the conventional system with manure and 60-85% than in the conventional system without manure. The ratio of microbial carbon to total soil organic carbon is higher in organic system as compared to conventional systems. The difference is significant at 60 cm depth.

Increased soil enzymes

Microbial activities reflect important functions in the soil system; soil enzymes indicate these functions. The total activity of micro-organisms can be estimated by measuring the activity of a living cell associated enzyme such as dehydrogenase (Jannee Bengtsson 2005). This enzyme plays a major role in the respiratory pathway. Proteases in soil, where most organic N is protein, cleave protein compounds. Phosphates cleave organic phosphorus compounds and thus provide a link between the plant and the stock of organic phosphorus in the soil. Enzyme activity in organic soils is markedly higher than in conventional soils. Microbial biomass and enzyme activities are closely related to soil acidity and soil organic matter content.

Wild flora

Large organic fields featured flora six times more abundant than conventional fields, including endangered varieties. In organic grassland, the average number of herb species was found to be higher more than in conventional grassland, including some species in decline. Vegetation structure and plant communities in organic grassland are more even and more typical for a specific site than in conventionally managed systems. In particular, field margin strips of organic farms and semi natural habitats conserve weed species listed as endangered or at risk of extinction. Animal grazing behavior or routing activity was found important in enhancing plant species composition (Jannee Bengtsson 2005). Weeds influence the diversity and abundance of arthropods and flowering weeds are particularly beneficial to pollinators and parasitoids.

High-energy efficiency

Organic farming follows the ecosystem theory of closed nutrient cycle on the farm. Organic land management allows the development of a relatively rich weed flora as compared to conventional systems. Some "accompanying plants" of a crop are desired and considered useful in organic management. The presence of versatile flora attracts beneficial herbivores and other air borne or above ground organisms. Their presence improves the nourishment of predatory arthropods. When comparing diversity and the demand of energy for microbial maintenance, it becomes evident that diverse populations need less energy per unit biomass. A diverse microbial population, as present in the organic field plots, may divert a greater part of the available carbon to microbial growth rather than maintenance. In agricultural practice this may be interpreted as an increased turnover of organic matter with a faster mineralization and delivery of plant nutrients. Finally, more organic matter is diverted to build-up stable soil humus.

Erosion control

Organic soil management improves soil structure by increasing soil activity and thus, reduces erosion risk. Organic matter has a positive effect on the development and stability of soil structure. Silty and loamy soils profit from organic matter by an enhanced aggregate structure. Organic matter is adsorbed to the charged surfaces of clay minerals. The negative charge decreases with increasing particle size. Silt is very susceptible to erosion since it is not charged, but organic matter layers on the silt surface favor aggregates with silt.

ENVIRONMENTAL BENEFITS OF ORGANIC FARMING

Soil: Soil building practices such as crop rotations, inter-cropping, symbiotic associations, cover crops, organic fertilizers and minimum tillage are central to organic practices. These encourage the growth of soil fauna and flora, improving soil formation and structure and creating more stable systems. In turn, nutrient and energy cycling is increased and the retentive abilities of the soil for nutrients and water are enhanced, compensating for the non-use of synthesized artificial fertilizers. Such management techniques also play an important role in soil erosion control. The length of time that the soil is exposed to erosive forces is decreased, soil biodiversity is increased and nutrient losses are reduced, helping to maintain and enhance soil productivity. Crop export of nutrients is usually compensated by farm derived renewable resources but it is sometimes necessary to supplement organic soils with potassium, phosphate, calcium, magnesium and trace elements from external sources.

Water: In many agricultural areas, pollution of groundwater sources with synthetic fertilizers and pesticide is a major problem. Organic farming never use artificial synthesized chemicals. In organic field inorganic fertilizer is replaced by the organic fertilizer and for plant diseases and pests, organic pesticide and ecological control methods are used. Organic matter enhances the water retention capacity in the soil. Well managed organic systems with better nutrient retentive abilities, greatly reduce the risk of groundwater pollution. In some areas where pollution is a real problem, conversion to organic agriculture is highly encouraged as a restorative measure.

Air: Organic agriculture reduces non-renewable energy use by decreasing agrochemical needs (these require high quantities of fossil fuel to be produced). Organic agriculture contributes to mitigating the greenhouse effect and global warming through its ability to sequester carbon in the soil. Many management practices used by organic agriculture (*e.g.* minimum tillage, returning crop residues to the soil, the use of cover crops and rotations and the greater integration of nitrogen fixing legumes), increase the return of carbon to the soil, raising productivity and favoring carbon storage.

Biodiversity: Organic farmers are both custodians and users of biodiversity at all levels. At the gene level, traditional and adapted seeds and breeds are preferred for their greater resistance to diseases and their resilience to climatic stress. At the species level, diverse combinations of plants and animals optimize nutrient and energy cycling for agricultural production. At the ecosystem level, the maintenance of natural areas within and around organic fields and absence of chemical inputs create suitable habitats for wildlife.

The frequent use of under utilized species (often as rotation crops to build soil fertility) reduces erosion of agro biodiversity, creating a healthier gene pool - the basis for future adaptation. The provision of structures providing food and shelter, and the lack of pesticide use, attract new or re-colonizing species to the organic area including wild flora and fauna (*e.g.* birds) and organisms beneficial to the organic system such as pollinators and pest predators.

Ecological services: The impact of organic farming on natural resources favors interactions within the agro-ecosystem that are vital for both agricultural production and nature conservation. Ecological services derived include soil forming and conditioning, soil stabilization, waste recycling, carbon sequestration, nutrient cycling, predation, pollination and habitats. By opting for organic products, the consumer through his/her purchasing power promotes a less polluting agricultural system. The hidden costs of agriculture to the environment in terms of natural resource degradation are reduced.

REFERENCES

Arulanandan Vekeesan, Tharshani Nishanthe, Gunasingham Mikunthan, (2007), *Green Manures, Natures gift to improve soil fertility*, 16, 17

Bengtsston, J., Ahnstrom, J., Weibull, A., (2005), *The effects of organic agriculture on biodiversity and abundance: a meta-analysis,* Journal of Applied Ecology Melbourne, Australia 42: 261-269.

IFOAM, (2006), *Definition of Organic Agriculture Report to the Task Force* International Federation of Organic Agriculture Movements, Germany, Pp78.

Jannee Bengtsson, Johan Ahnstrom, Ann Christinweibull,(2005), *The effect of organic Agriculture on biodiversity and abundance.*

Lotter, D.W.,(2003), *Organic agricultur,*. The Rodale Institute, 611 Siegfriedale Rd., Kutztown, PA 19530, Pp 45-56.

Nadiael huge scialabba, (2007) *Organic Agriculture and soil biodiversity.*

Subhashini Sridhar, S. Arumugasamy. H. Saraswathy. K.Vijayalashmi, (2005), *Organic vegetable gardening.* Center for Indian knowledge system Chennai