COMMUNITY EXTENSION SERVICES FOR SUSTAINING SOIL BIODIVERSITY

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Introduction

Soil biodiversity represents the variety of life below ground, which plays many fundamental roles in delivering key ecosystem goods and services. Maintenance of soil biodiversity is essential to both the environment and to agricultural industries. A teaspoon of topsoil typically contains a vast range of different species and up to 6 billion microorganisms. Soil biodiversity reflects the variability among living organisms in the soil - ranging from the myriad of invisible microbes, bacteria and fungi to the more familiar macro-fauna such as earthworms and termites. The activity of soil biodiversity can be stimulated by improving soil living conditions, such as aeration, temperature, moisture, and nutrient quantity and quality (Nadia, 2000). Soil organisms are essential for nutrient cycling, modifying soil physical structure and water regimes, suppressing pests and diseases, soil carbon sequestration and greenhouse gas emission and break down of organic matter. Soil biodiversity is increasingly recognized as providing benefits to human health because it can suppress disease-causing soil organisms and provide clean air, water and food.

Soils that support natural, non-agricultural ecosystems usually have the greatest soil biodiversity. soils that receive less manufactured inputs (e.g. chemical fertilisers and pesticides) generally have higher soil biodiversity. Cropping systems generally have low soil biodiversity, unless they increase inputs of carbon and nitrogen to the soil, which will increase soil microbial populations. Soil biodiversity can be maintained and partially restored if managed sustainably. Application of organic matter to the soil, such as crop stubble, supports greater soil biodiversity.

As the agricultural production is becoming more intensive, effective management of available limited resources, viz., land, water, sunlight and crop residues is critical in improving production and productivity. Among these, the use of crop/farm wastes for mass multiplication of beneficial microbes is one of the important tools for sustainable production. On-farm management of agricultural wastes not only improves the soil health but increases the farmer's profit also. One of the practical ways to manage agricultural waste is to recycle it for the mass multiplication of beneficial microbes. The availability of waste biomass from a well managed coconut garden with 175 trees/ha has been estimated as 14 tonnes /ha/year in the form of leaves, spathe, bunch waste and husk (Subramanian et al., 2005). These organic wastes can be utilized as mulch or converted to composts by employing earthworms or microbial cultures. The organic inputs produced by recycling farm wastes may be efficiently utilized for soil biodiversity conservation, thereby boosting crop diversification and income from farming systems. Community level production of organic inputs from crop residues can be a potential source of income for farmers' groups.

CPCRI has standardized several agro techniques viz., soil moisture conservation practices using husk/coir pith for growing different crops, green manuring, basin management with leguminous crops, direct utilization of coconut wastes for soil conservation measures, vermicomposting of coconut plantation wastes and irrigation for increasing the yield of coconut palm. In a research study conducted at CPCRI by Thomas and Shantaram (1984), it was found that promising legume crops grown during a period of 140-150 days generated 15-28 kg of biomass and 102-197g of nitrogen in the basin of a coconut palm. By adopting such agro techniques, the soil biodiversity can be enhanced so as to achieve sustainable production and income from farming systems. However, the importance of bioresource management and conservation of soil biodiversity are yet to be exploited by the farming community on a larger scale in their farm holdings. Hence, it is imperative to enhance the knowledge level of farmers and other stakeholders on these aspects to ensure sustainable production and livelihood security.

In addition, bioresource management through production and utilization of organic inputs will generate employment and contribute to economic upliftment and livelihood security of the farmers/rural youth/farm women. In addition to the benefit of ensuring income to the entrepreneurs, this will ensure quality bio-inputs to the farmers, thereby contributing to sustainable production and productivity. Efficient utilization of the bioresources coupled with other technological interventions will enhance the income from coconut, intercrops and other allied enterprises to the tune of 25-50%. However, thorough awareness creation on the importance of bioresource management and effective use of bio-formulations at a wider level is very much essential in obtaining desired outcome. Decentralized production and utilization of bio-inputs on a community basis can result in proper utilization of bioresources, thereby contributing to protection of environment and promotion of sustainable agriculture.

Issues related to Bio-resource Management

1. Lack of clarity on the utilization of crop residues – burning for ash / utilization as mulch or green manure / recycled as compost.
2. Low awareness on environmental issues and potential benefits of agricultural wastes
3. Inadequate knowledge on composting techniques.

4. Lack of knowledge on the quality, storage and availability of bioformulations.
5. Inadequate knowledge on the effective utilization of bioformulations – ideal substrates to be used for multiplication, moisture level to be maintained and mode of application.
6. Lack of proper knowledge on problem-based application of bioformulations.

Community level Integration of Bioresource Management for Sustaining Soil Biodiversity

Community responsibility needs to be imbibed by creating awareness on the needs and benefits of recycling bio-wastes viz., importance of plant waste recycling in maintaining soil and plant health, benefits in terms of soil and water conservation, protection of environment by way of reduced use of chemical fertilizers etc., which all can lead to enhanced biodiversity in soil.

USDA Natural Resources Conservation Service (1998), in their Soil Quality Information Sheet described the good agricultural practices for conserving soil biodiversity as follows:

Cultivation

Tilling to greater depths and more frequent cultivations has an increased negative impact on all soil organisms. No-till, ridge tillage, and strip tillage are the most compatible tillage systems that physically maintain soil organism habitat and biological diversity in crop production.

Compaction

Soil compaction reduces the larger pores and pathways, thus reducing the amount of suitable habitat for soil organisms. It also can move the soil toward anaerobic conditions, which change the types and distribution of soil organisms in the food web. Gaps in the food web induce nutrient deficiencies to plants and reduce root growth.

Pest control

Pesticides that kill insects also kill the organisms carried by them. If important organisms die, consider replacing them. Plant-damaging organisms usually increase when beneficial soil organisms decrease. Beneficial predator organisms serve to check and balance various pest species. Herbicides and foliar insecticides applied at recommended rates have a small impact on soil organisms. Fungicides and fumigants have a much greater impact on soil organisms.

Fertility

Fertility and nutrient balances in the soil promote biological diversity. Typically, carbon is the limiting resource to biological activity. Plant residue, compost, and manure provide carbon. Compost also provides a mix of organisms, so the compost should be matched to the cropping system.

Cover crops and crop rotations

The type of crops that are used as cover or in crop rotations can affect the mix of organisms that are in the soil. They can assist in the control of plant pests or serve as hosts to increase the number of pests.

Crop residue management

Mixing crop residue into the soil generally destroys fungal hyphae and favors the growth of bacteria. Since bacteria hold less carbon than fungi, mixing often releases a large amount of carbon as carbon dioxide (CO2). The net result is loss of organic matter from the soil. When crop residue is left on the soil surface, primary decomposition is by arthropod shredding and fungal decomposition. The hyphae of fungi can extend from below the soil surface to the surface litter and connect the nitrogen in the soil to the carbon at the surface. Fungi maintain a high C:N ratio and hold carbon in the soil. The net result is toward building the carbon and organic matter level of the soil. In cropping systems that return residue, macro-organisms are extremely important. Manage the soil to increase their diversity and numbers.

Massive sensitization of farmers and social groups on the above bioresource management concerns can reduce the rate of soil biodiversity erosion to a great extent, which can be achieved at community level by coordinating grass root level farmer organizations (FOs).

Steps in Community level Integration of Bioresource Management for Sustaining Soil Biodiversity

i. Awareness creation and capacity building :

To begin with, thorough awareness creation should be done at all levels, which may ensure the involvement of all stakeholders in the programme by way of involvement in effectively utilizing bioresources through recycling of biowastes and enrichment with microbial agents. and also in creating demand for the product. Farming community should be educated on the production of various bio-inputs, quality parameters and regulations to be followed, benefits and specific use of the bioformulations, mode of application and ideal conditions for mass multiplication and field maintenance.

- Awareness campaigns on the importance of Bio-resource management for Officers of State Department of Agriculture, farmer groups and farmers

- Capacity building for the members of Bioagent production unit - Culturing and multiplication in coconut water media, preparation of talc based formulations & production of organics from locally available resources and enrichment using bioagents

- Capacity building for farm women/youth on mass multiplication of bioagents in crop waste

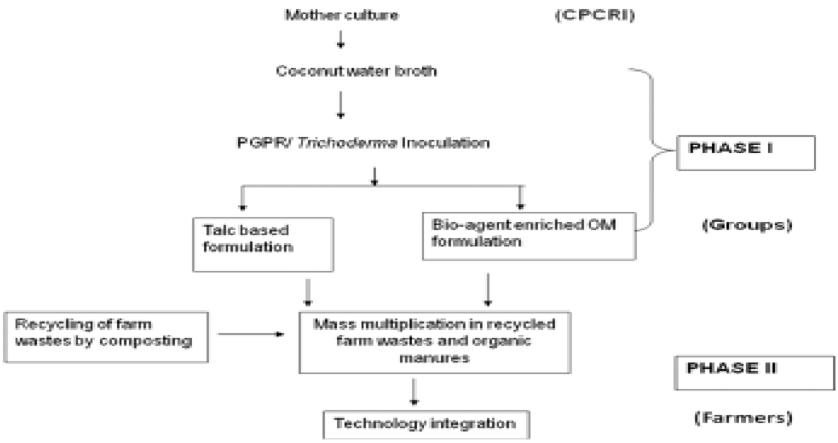
- Capacity building for farmers on production of organics, enrichment using bioagents and utilization for soil and plant health management

ii. Establishment of bioagent units at district level involving 3-4 members for culturing, multiplication in liquid media and decentralized production of formulations of beneficial microbes. Training should be imparted on handling of microbial cultures, inoculation, culturing, mass multiplication of bioagents in locally available and cheap media like coconut water and production of talc based formulations.

iii. Small scale organic input production units at block level involving 5-6 members each can be identified for production of organics (composts) from locally available resources and enrichment of compost/ farmyard manure/ neem cake with talc based formulations of bioagents. This can be linked with selected Coconut Producer Societies (CPS) as an income generation activity.

iv. Farm level technology integration involving production of organics from crop residues, enrichment using bioagents, utilization of enriched organics for soil and plant health management and production of bio-primed planting materials. Organic recycling along with soil moisture conservation measures in Coconut Based Farming System can be integrated by CPSs/FOs. Growing and incorporation of green manure crop and soil test based nutrient application if integrated can ensure higher and sustained production in Coconut Based Farming Systems.

Activity Flow Chart



Community based Bio-resource Management: Success story from Kanjikuzhy Block of Kerala

Kanjikuzhy Block being a known organic tract of Kerala, the farmers widely use several microbial formulations for plant growth promotion and disease suppression. Most of the farmers were using talc based or liquid formulations without having a thorough knowledge on their effective utilization. As the talc based formulations are costly, the farmers were educated on the technique of mass multiplication of the bioagents on organic substrates. This could help the farmers in reducing the cost of application by 50%. Mass multiplication of bioagents depends largely on the substrate used for mass multiplication and the method of culturing. The farmers of Kanjikuzhy were found to use the bioagents, mainly Trichoderma sp. in soil along with different organic substrates and hence the locally available substrates used by the farmers of Kanjikuzhy Block area were evaluated for their suitability. The results revealed coir pith compost, neem cake, vermicompost and cow dung as well as their combinations as ideal substrates and poultry manure and goat manure as poor substrates for mass multiplication of bioagents. Poutry manure and Goat manure in small quantities upto 20% with other substrates favoured the growth of microbes.

Under a trial with chillies, Growth rates of two isolates of Trichoderma (CPCRITD 28- CPCRI culture and KKT-6 from Kanjikuzhy) were found to be highest in Coir pith compost + Neem cake (4:1) combination, but on soil application, the highest growth rate was observed in Cowdung + Neem cake (4:1) treatment. However, highest and sustained yields were obtained from the plants treated with Cowdung + Neem cake (4:1), which was on par with Coir pith compost + Neem cake + Poultry Manure + Cowdung (2:1:1:1). Higher yield in the above two medium can be attributed to the optimum levels of microbial population in the enriched organic mix as well as soil coupled with higher nutrient levels in the treated plants. Correlation analysis also revealed that the population of Trichoderma harzianum in soil and Nitrogen content of the soil were found to be significantly associated with the yield of chillies. Wachira et al. (2014) observed that the efficacy of bio-inoculants, especially when combined with manure and fertilizers, had a positive and synergistic effect on yield in maize. Okoth et al. (2011) recommended that repeated application of the bio-inoculants should be encouraged to build up their numbers in the soil.

Hence, it was inferred that while enriching organics with microbial agents, the population count in the enriched manure alone should not be the only factor to be considered, but also the soil microbial population and nutrient status after application. Application of the two enriched substrate combinations, viz., Coir pith compost + Neem cake + Poultry Manure + Cowdung (2:1:1:1) and Cowdung + Neem cake (4:1) were found to be ideal in ensuring disease suppression, improved growth and sustained yield from crops like vegetables, ginger, turmeric, pepper etc.

Apart from the utilization of ideal microbial enriched organic mixtures, the farmers were also educated on preparation different composting techniques like vermicomposting, coir pith composting with and without urea, hillock composting for large scale on-site composting, biofertilizers and biopriming of coconut seedlings. Biopriming of coconut seedlings with Trichoderma sp. was proved to enhance the growth of coconut seedlings - higher collar girth, height and number of leaves, apart from inducing systemic resistance.

By integrating bioresource management as a component of soil test based management coupled with soil moisture conservation, the income from CBFS was enhanced by 62% , the details of which is provided below:

Components	Income (Rs. /ha)	
	2014-15	2015-16
Coconut	24,475	28,539
Intercrops		
Banana	15,104	36,768
Vegetables	26,123	55,821
Tuber crops	9914	15,509
Spices	2699	3,562
Others	9529	18,147
Total	63,369	1,29,807
Livestock/other enterprises	41,412	54,202
Total Farm income	1,29,256	2,10,099

The higher net income from holdings were mainly due to improved soil health and reduction in cost of cultivation through proper utilization of available local bioresources coupled with adoption of moisture conservation techniques.

Conclusion

Lack of awareness, knowledge, and understanding of soil biodiversity has been identified as the major constraint on sustainable ecosystem management and crop production. As soil organisms are the primary agents of nutrient cycling and modification of the soil structure, agricultural activities that promote their population in the soil should be promoted for crop production. However, with increasing demand for land, crop intensification has become the major challenge in the conservation of soil biota. Hence , it is the need of the hour to educate the farmers on the importance of conserving the biodiversity of soil through good agricultural practices. Community level adoption of bioresource management for enhancing soil biodiversity can be strengthened by building the community capacity for the utilization of all possible biota viz., Rhizobium bacteria, Mycorrhiza, earthworms, nematodes and other microbial population for decomposition process, plant growth promotion, biological suppression of pests and diseases and in eliminating environmental hazards resulting from accumulations of toxic chemicals or other hazardous wastes. Community based production and utilization of bio-formulations and organic inputs at local level can ensure the availability of quality bio-inputs for repeated application so as to build up required population necessary for soil biological activities and sustainable crop production. In addition to the improvement in production and income from farming systems, community based production of organic inputs will generate more employment opportunities and income to rural youth / farm women. Community level efforts to manage bioresources can contribute to improvement in livelihood opportunities of the small and marginal coconut farmers coupled with conservation of natural resources and protection of environment.

References

1. Nadia El-Hage Scialabba. 2000. Organic Farming Enhances Soil Fertility ad Biodiversity. Institute of Organic Farming (FiBL), Frick, Switzerland. In: FAO repository. http://www.fao.org/ORGANICAG/doc/soil_biodiversity.htm
2. Okoth SA, Jane AO, James OO (2011) Improved seedling emergence and growth of maize and beans by Trichoderma harzianum. Trop Subtrop Agroecosyst 13:65–71
3. Thomas, G. V. and Shantaram, M. V. 1984. In situ cultivation and incorporation of green manure legumes in coconut basins. Plant and Soil. 80: 373-380.
4. Subramanian, P., Reddy, D.V.S., Palaniswamy, C., Upadhyay, A.K. and Gopalasundaram, P. 2005. Studies on nutrient export and extent of nutrient recycling in coconut based HDMSCS (High Density Multispecies Cropping System). CORD.21(1):20-27.
5. USDA (1998). Soil Quality Resource Concerns: Soil Biodiversity. Soil Quality Information Sheet - USDA Natural Resources Conservation Service. http://soils.usda.gov
6. Wachira P., Kimenju J., Okoth S., Kiarie J. (2014) Conservation and Sustainable Management of Soil Biodiversity for Agricultural Productivity. In: Kaneko N., Yoshiura S., Kobayashi M. (eds) Sustainable Living with Environmental Risks. Springer, Tokyo