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SOIL REVIVAL ECOFRIENDLY FARMING FOR AGRICULTURE SUSTAINABILITY

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Abstract : Mavelikkara thekkekara panchayath's paddy farming is declining due to poor microbial activity, nitrogen depletion, and soil deterioration. Our study looked into how Effective Microorganisms (EM) could be able to help with these issues. The effects of control, EM-treated, and NPK-treated seed on paddy growth and yield were examined in laboratory and greenhouse experiments. According to the results, seeds treated with EM had the highest yield and growth promotion. Soil study demonstrated better microbial diversity, nutrient availability, and decreased pathogen. These findings revealed that this strategy should not only stimulate plant growth but also serve as a solution to preserve the soil's natural state.

Index terms **:** Soil revival, EM solution, Sustainable crop production, biocontrol agents

I. Introduction

Soil health is a keystone of agriculture and ecological sustainability. Modern agriculture practices, urbanization and environmental degradation have led to significant soil depletion, diminishing soil fertility and biodiversity. Soil revitalization has emerged as a critical approach to restore and enhance the natural vitality of soils. Ensuring their capacity to support plant growth, retain moisture, and foster a diverse microbial community.

A microbial inoculum called Effective microorganisms (EM) together with organic material was introduced to “nature family system” in Japan in the early 1990s (Higa, 1994), The EM inoculants are liquid microbial concoctions containing yeasts, actinomycetes, lactic acids and photosynthetic bacteria (M J Daly and D. P .C Stewart,1999). Since the majority of species rely on organic sources for both carbon and nitrogen, when combined with organic materials to provide both nutrients, EM inoculation has shown greater success (Yamada and Xu, 2000). In addition to plant hormone production, advantageous bio-active substances, and antioxidants, the microorganisms in the consortium's also solubilize nutrients (Higa and Parr, 1994).

Paddy field represents one of the most productive land ecosystems on earth, Rice (*Oryza sativa* L.) is the staple diet of over 50% of the world’s total population making it the most important food crop currently producing, Alappuzha holds the second position in terms of rice cultivation in Kerala. The three major rice-growing seasons of Kerala are virippu, (April-May to September to October), Mundakan (September- October to December-January) and Puncha (December-January to March-April). The area production productivity of paddy in the year 2021-2022 was 1.94 lakh Tonnes and 2884 kg/hector. Alappuzha has a share of 12.8% Pf area under paddy cultivation.
The application of EM results in an increase in soil organisms that are beneficial for plant growth, resulting in more rapid mineralization of organic matter, suppression of soil borne pathogens and increased crop yield and quality (Asia Pacific Natural Network, 1995) other studies have shown that inoculation of the agro-ecosystem with EM leads to an improvement in soil and quality in addition to highest crop yields (Higa and Parr, 1994: Li and Ni, 1995).

This project focuses on the use of effective microorganisms (EM) solution as a revolutionary technique for soil revitalization. EM technology (Dr. Teruo Higa, 1980) uses a synergistic mixture of beneficial microorganisms, such as photosynthetic bacteria, lactic acid bacteria, and yeast, to improve soil structures, improve nutrients for healthier plant growth, and increase agricultural productivity. This project aims to evaluate the effectiveness of EM solutions in various soil types and agricultural contexts tthrough empirical research and field trials. By analyzing key indicators of soil health-such as microbial diversity, organic matter content, and overall fertility-this study seeks to provide valuable insights into the role of effective microorganisms in sustainable soil management practices. Furthermore, we will explore the ability of EM solutions to mitigate the negative impacts of chemical fertilizers and pesticides promoting an eco-friendlier approach to agriculture.

In Conclusion this project not only aims to advance scientific understanding of soil revitalization techniques but also aspires to contribute to the broader movement toward sustainable agricultural practices and environmental sustainability by using the effective microorganisms. We hope to pave the way for healthier soils a more resilient ecosystem.

II. OBJECTIVES

- To identify the primary challenges faced by farmers during paddy cultivation in Mavelikara, Thekkekara Panchayath.
- To comprehend farmers' perspectives, obstacles, and tactics about the reduction in paddy farming.
- To identify potential solution for sustainable agriculture.
- Investigate the effectiveness of Effective microorganism (EM) solution in revitalizing soil fertility and structure

III. HYPOTHESIS:

Application of Effective microorganism(EM) solution will improve soil physical, chemical and biological properties and enhance crop growth and yield.

IV. MATERIAL AND METHODS MATERIALS:

3.1 Study site

Location	: Thekkekara
Soil Type	: Sandy Soil
Longitude & Latitude	: 9.4981 N, 76.3388 E

3.2 Background of the problem:

Climate change, weathering, soil erosion, geological processes, pests, and diseases are the causes of soil deterioration and nutrient depletion. Intense farming, overgrazing, and urbanization are additional contributing factors.

3.3 Identification of the problem:

A structured questionnaire was used to directly collect data from 100 farmers in the chosen panchayath. The local agriculture officer assisted in gathering the data. The first part of the questionnaire included demographic features. The second section contains information about agricultural land and crops. Third part includes soil problems and the methods they done to solve them, and about the consequences they faced due to soil degradation.

3.4 Experimental Design

Include three treatments

- Control (**T0**)
- Treated with Effective microorganism (**T1**)
- Treated with NPK (**T2**)

3.5 Effective Microorganism Solution (EM)

Obtained from Central Plantation Crops Research Institute(CPCRI), Kayamkulam (Ready to Use)

3.6 Rice Seeds

Certified rice seeds, Uma MO16 Variety obtained from seed testing lab, Alappuzha.

3.7 Method-I

3.7.1 Data collection

Primary data collection by a survey of 100 paddy farmers of Mavelikkara Thekkekara panchayath using a structured questionnaire.

3.7.2 Interview with agriculture officer

We conducted an interview with agriculture officer of Thekkekara panchayath on 24th April 2024.We asked 10 questions relating to paddy cultivation.

3.7.3 Soil health card analysis

Soil health card collected from 100 farmers of Mavelikkara Thekkaekara Panchayath and analyses to determine soil quality and recommendations.

3.8 Method II

3.8.1 Collection of soil samples:

Soil sampling was carried out systematically by collecting samples from randomly selected five wards of Mavelikara Thekkekara panchayath by random sampling Method (5x2=10). Soil samples collected from from sampling unit, removed soil according to the soil sampling procedure. The Soil sample were collected at the depth of 20cm from each ward and mixed well to obtain complex sample for soil analysis.

3.9 Method-III

3.9.1 Inoculation of rice seeds with Effective microorganism's solution:

This experiment includes three treatments:

1. Hundred Rice seeds are soaked in 10% Effective microorganism Solution in 5 hours (Treatment 2-T2)
2. Hundred Rice seeds were soaked in 10% NPK Solution in 5 Hours.(Treatment 3-T0)

3.10 Growthpromotion studies

3.10.1 In lab condition the hundred rice seeds were T0, T1 and T2

The percentage of seed germination was noted after two days. The shoot lengths, root length fresh weight, dry weight was recorded every 7,14,21,28 days of growth. The treatment includes control, EM treated seeds and NPK treated seeds replicates with T1, T0, T2 in 4 trays After every 7 days 5ml EM solution and NPK solution were applied at uniform intervals by soil drench method.

3.10.2 In Green House condition

The treated seeds T0, T1, and T2 were sowed (50 Seeds) into pots (24cm X 12cm). The percentage of germination was noted after two days, plant growth parameters recorded after 7,14,21,28 days of growth.

3.11 Field study

Field trial experiment conducted before distribution of EM Solution for farmers group.
The area selected for field trial in ward 12 of Mavelikkara -Thekkekara panchayath soil analysis was also conducted. The plant growth parameter and yield are compared with control after 90 days of growth.

Equation

$$\text{Germination Percentage} = \frac{\text{No of seeds germinated}}{\text{Total number of seeds sown}} \times 100 \qquad (3.1)$$

3.12 Introduction of EM Solution at Kudumbashree yogam

We introduced this solution in the Kudumbashree unit of Mavelikkara Thekkekara ward 4 on 27 July and explained them how this solution woks and regain the life of soil with the help of beneficial microorganism again we conducted a demonstration about how the solution can be used for preparing bio compost.

V. RESULT

3.1Results of survey and questionnaire

With the aid of a questionnaire, we gathered the farmers' primary data (**Fig.2**). According to the data gathered, we discovered that the soil has degraded as a result of the overuse of chemical fertilizers and pesticides. The primary cause of this deterioration is that the chemical fertilizers and pesticides have destroyed all of the soil's beneficial microbes and earthworms. According to the main data, 80% of farmers stopped growing paddy because of issues with the soil, 14% because of issues with marketing, and 6% because the government didn't help them.

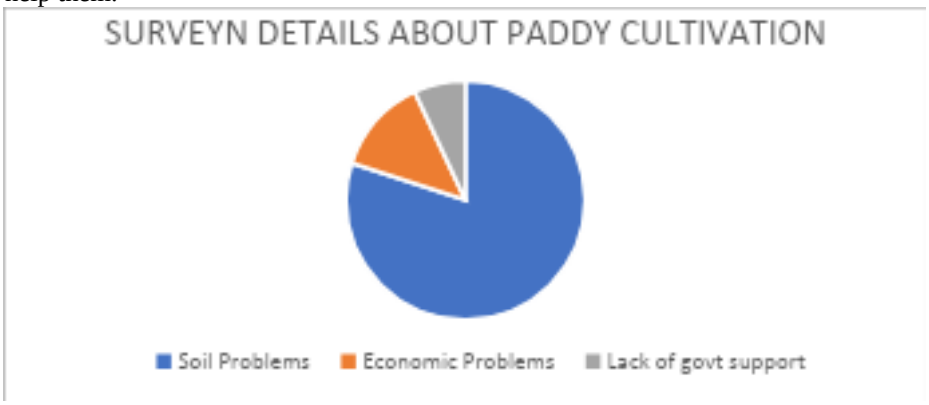

Fig.1 Pie diagram showing the data observed during the survey.

Fig.1 survey with local farmers and discussions with experts.

3.2 Results of soil sampling

Secondary step we interviewed agriculture officer at Mavelikkara Thekkekara Panchayath. She also confirmed our findings. For scientific confirmation we collected samples of the soil from our study areas(**Table.3**) and took it to the soil testing lab, Alappuzha. The outcomes further demonstrated the accuracy of our conclusion(**Fig.4**).

Fig.3 soil collection from Mavelikkara-Thekkekkara panchayath.

Table 1. The pH of of collected soil from various wards of Thekkekkara panchayath.

SL. NO.	PROPERTY	pH VALUE
1	W1 (Umbernadu west)	5.2
2	W 2 (Palliyavattom)	5.4
3	W3 (Varenickal)	5.8
4	W4 (Kurathikad)	5.3
5	W 5 (Thadathilal)	4.8
6	W 6 (Vathikulam)	5.7
7	W 7 (Olakettiambalam)	5.3
8	W8 (Ponakam	5.2
9	W9 (Pallarimangalam)	4.9
10	W10 (Mullikulangara)	5.3

Table 1 Displayed the pH values of soils of study areas,which is obtained after soil analysis .Soil pH range from 4.8-5.8.an acidic pH is conformed for the soil fields.

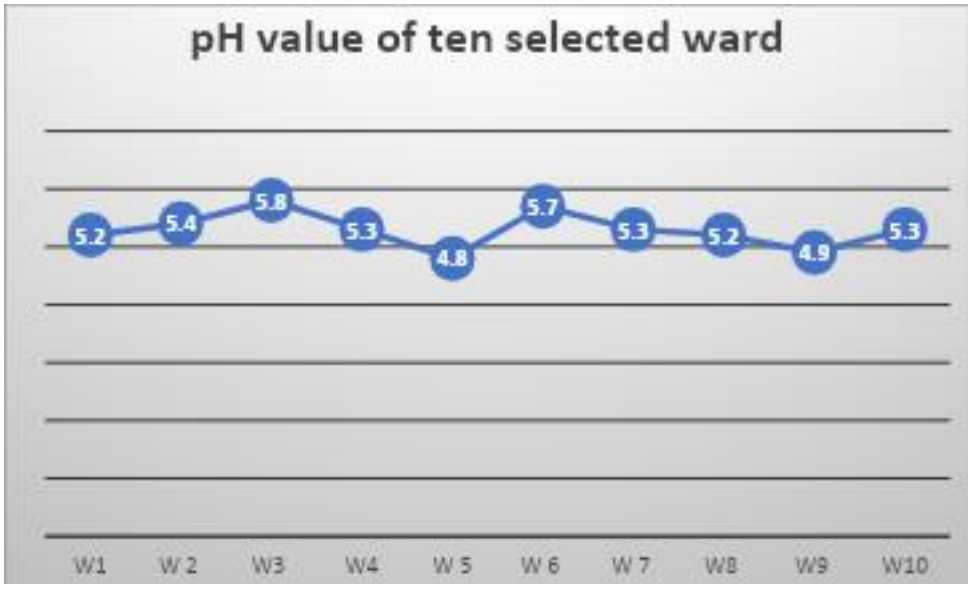

Fig.4 showing the pH of the soil samples collected from 10 wards of Mavelikkara-Thekkekkara panchayath.

Table 2. Soil sampling result before and after adding EM solution Data represents average value of 10 soil samples from study area.

SL.NO	PROPERTY	VALUE	
		BEFORE	AFTER
1	PH	3.8	4.2
2	Electrical conductivity (ECE)	7.4	8.6
3	Cation exchange capacity (CEC)	10.4	12.4
4	Caco3	5.3	6.4
5	N (%)	0.02	0.08
6	P (%)	3.28	5.21
7	K (%)	31.2	48.4
8	Fe (mgkg-1)	1.24	2.78
9	Mn (mgkg-1)	4.26	6.21
10	Zn (mgkg-1)	0.61	0.96
11	Cu (mgkg-1)	0.81	0.62

Table 2 represents the variations in the soil properties after and before the treatment with EM solution in the soil. As a Soil health card analysis pointed out that there is a difference in the recommended fertilizer for each crop. The soil of this panchayath is more deficient in potassium. The soil health card recommends the use of fertilizer with higher potassium content. Nitrogen content ranged significantly increased relative to the control treatment, phosphorous ranged from 3.28, soil available potassium ranged from 31.2 Application of EM solution increased available potassium relative to the control and NPK treatment.

Table.3 N,P&K values of the field before & after the treatment with EM solution

CROP	Conventional method Recommended dose Kg hectare per year				After adding EM solution Recommended dose Kg hectare per year			
	N	P	K	TOTAL	N	P	K	TOTAL
PADDY	145	202	454	801	47	102	184	333

Table.4.The effect of growth promotion under lab condition

Treatment	Germination %	Shoot Length (SE)	Root Length (SE)	Fresh Wt. (SE)	Dry Wt. (SE)
T0	85.3	0.78	0.68	0,01	0.005
T1	98.4	0.48	0.26	0.11	0.002
T2	89.2	0.19	0.23	0.08	0.003

Table 4 displays the applied Condition-I (In lab condition) Data represent average value of 5

Table 5. Pot study analysis results

Treatment	Germination %	Shoot Length	Root Length	Fresh Weight	Dry Weight
T0	84.4	0.07	0.11	0.007	0.034
T1	98.7	0.75	0.04	0.036	0.031
T2	88.2	0.08	0.12	0.007	0.036

Table 5 shows the significant growth in pot cultivated plants with incresed gerimination,shoot length ,Root length , Fresh weight and dry weight when treated with EM solution.

Fig.5 Germination and plant growth analysis within the lab conditions until 28th weeks.

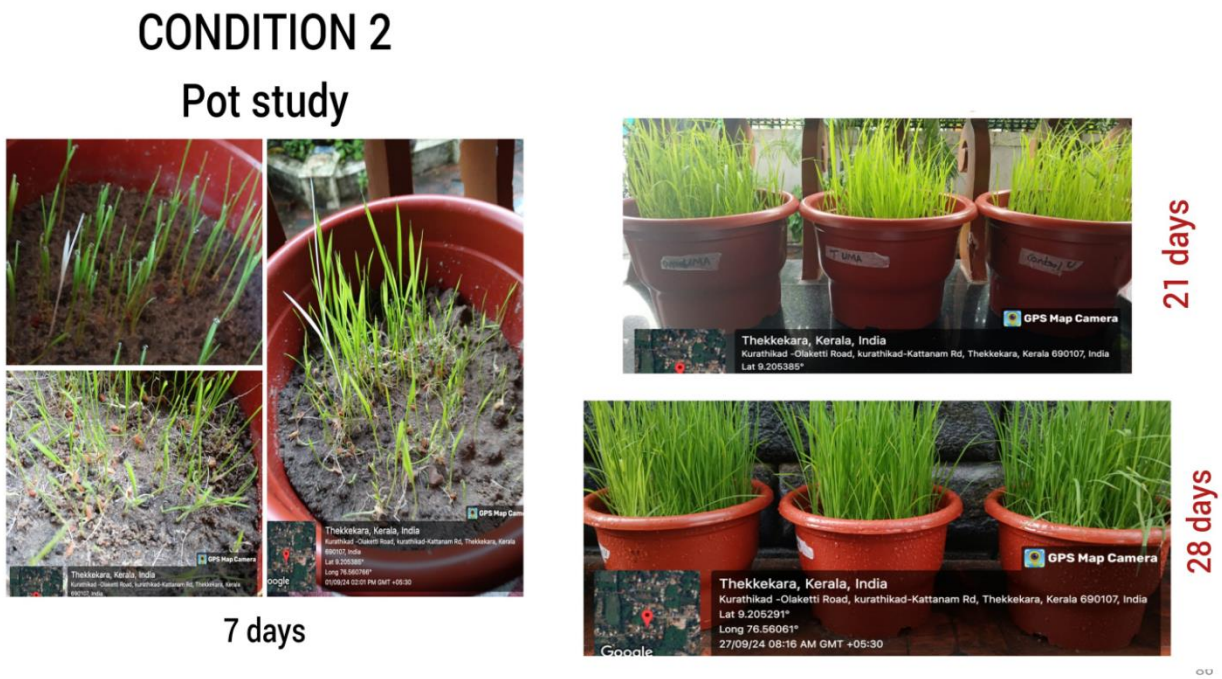

Fig.6 The growth promotion study within the pots under in-vitro conditions up-to 28th week.

Condition-I

Data represents the average value of 5 replicates after 28 Days.

From this result, it is found that the treatment T1-seed treated with EM solution produces maximum germination % shoot length fresh weight as compared with T0 (control) and T2 (seeds treated with NPK)

FIELD STUDY –RESULT

Treatment	Total No of grains per ear	Healthy grains (SE)	% of Healthy grains (SE)	Total No Off Chaff (SE)
T0	54	1.5	0.12	0.87
T1	95	0.86	0.69	0.71
T2	62	3.2	0.70	1.48

The result of the field study verify that T1 shows maximum growth parameters, shoot length, root length, fresh weight and dry weight than T0, Control and T2. The percentage of health grain is maximum in T1 than control and T2. The reduction in number of chaff grain indicated that EM treated seeds promote not only growth but also promote yield.

We conducted demonstration class in Kudumbasree with help of slides, that can bring self-reliance in vegetables for their family. As the results that proven effective on the farmland and with farmers, Kudambasree members showing positive response, this method will make paddy cultivation Vegetable activation and profitable by avoiding chemical fertilizers and pesticides. This will make agriculture profitable and pave way for making farmers self-reliance and financially stable. Moreover, the life of the soil is revived. Pollution will be reduced from earth and air. This will make our society physically healthier and economically stable. On hearing the class and seeing the demonstration of preparing the bio composts, the unit members were ready to use this method in paddy, vegetable cultivation and banana cultivation. They were ready to make mini compost unit in every household because they could convert vegetable waste and other biodegradable material into other degradable material into useful fertilizer, which can be used for organic farming. Kudumbasree members identify that this solution is a substitute for chemical pesticides and chemical fertilizers and it is also very cheap.

VI DISCUSSION

Data collection from the study area helps to identify challenges faced by farmers of Mavelikkara Thekkekara panchayath. EM inoculation to the soil can improve the physical and chemical features of soil (Hans et al 2006). Effective microorganisms enhance over all plant's health and soil health (Sun et al., 2014).The result obtained in this study showed that EM (Effective Microorganisms) solutions had a positive effect in seed germination. This suggests the EM solution had a significantly higher possibility due to the production of plant growth regulators. Similar results were obtained by Xu et al., (2000) where the application EM increased plant growth of tomato plant. Earlier studies also pointed out that EM solution can increase yield of crop by accelerating the breakdown of organic matter from crop residues (Cartez et al 2000). This study showed that N P K levels increase with the use of EM solution. Previous studies reported that EM solution will increase nutrient enrichment in the soil, which will reduce constant fertilization and cost of cultivation (Daniel et al.,1992). Jusoh et al., (2013) reported that compost applied with effective microorganism has more NPK content compared to compared to control. Nikolopoulou and Kalogerakis (2010) suggested that EM solution has the self-purification ability of rivers. Our study also pointed out that EM solution not only promotes plant growth but also yield. The use of EM solution can suppress soil borne diseases and increase the decomposition of organic materials and simultaneously the availability of nutrients to plants (Sing et al., 2003).

Thekkekara Panchayath is situated in the Mavelikkara Taluk, in the heart of Onattukara region. Onattukara has a rich heritage in the cultivation of its traditional variety of rice and its best variety of sesamum that got G1 tag. This region was once famous for its puncha cultivation once in a year tulappala which followed above flood virippu cultivation. It was done twice in a year followed by the famous sesamum.

Unfortunately, like other parts of Onattukara the paddy cultivation of Thekkekara Panchayath is also decreasing at an alarming rate due to a variety of reasons from labor shortage to marketing, the farmers face a variety of problems. But the major factor that forces farmers to give up paddy cultivation is the low yield caused by soil degradation. The soil has become nearly arid due to micronutrient depletion, insufficient microbial activity, and the extinction of the earth worm, one of nature's finest buddies in rice fields. We conducted a detailed study by different methods. Our team interviewed farmers, agriculture officers with a detailed questionnaire. We collected soil samples and sent to soil testing lab at our Panchayath. Then we sent to CPCRI Kayamkulam and also consulted the research wing of SD college Alappuzha who has a vast experience in this area. The scientist of CPCRI advised us to use the EM solution as a best remedy for soil revival. The crop was shown to benefit most from the EM solution's efficiency in both lab and pot conditions. We found that this solution has significantly increased NPK, micronutrients and microorganisms. Our experimental plants' remarkable development demonstrated the potential of soil regeneration as a sustainable agricultural method.

VII CONCLUSION

Sustainable agriculture is vital in today's world as it offers the potential to meet our needs. An ideal agricultural system is sustainable maintains and improves human health benefits environment and produces enough food for increasing world population. Effective microorganism (EM) solution offers an environmentally sustainable approach to increase crop production and soil health.Although EM solution can be considered a promising and environmentally friendly technology for sustainable agriculture, more studies are needed to elucidate the mechanism of action of EM as well as its efficiency under field conditions.

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