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Research Article

SOIL RELATED ENVIRONMENTAL ISSUES AND ENVIRONMENT SAVING SUSTAINABLE SOIL MANAGEMENT PRACTICES: AN ANALYSIS WITH REFERENCE TO THE HILLY TRIBAL ECOSYSTEM

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Abstract: Among the natural resources, soil is a finite, non-elastic and non-renewable asset. Soil degradation is a major threat worldwide. Hence, the present study was taken up to document the soil related issues and also to study the awareness and perception level of the respondents on the probable causes for each issues. The Nilgiri district of Tamil Nadu was selected for this study considering the highest proportion of tribal population in the district. Ex-post facto research design was used. The study was conducted in all the blocks of The Nilgiri district with a total sample of 214 respondents who were selected by employing proportionate random sampling method. Data were collected by using structured and standardized interview schedule. Percentage analysis was done to get meaningful interpretation of the results. The results shared visible level of gap in the awareness and perception level of the respondents on the documented environmental issues. There existed wide variations in the degree of acceptance of the sustainable soil management practices by the respondents. Appropriate educational strategies to be framed to bridge the above gap.

Keywords: *Awareness, Perception, Soil Fertility, Sustainable Soil Management Practices, Tribal Ecosystem*

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Introduction

Ever since man appeared on the earth, he has been harnessing the natural resources to meet his basic requirements. Reference to soil, water and air as basic resources, their management and means to keep them pure are mentioned in Vedas and Upanishads, the ancient Hindu literature [1]. There has been an increasing alarm regarding the deterioration of country's environment and the condition of the natural resources are worsening due to the over exploitation of the natural resources. The ecological balance in the nature is disrupted by many factors such as population explosion, rapid industrialization, modern agricultural practices, unplanned developmental activities, tourism, *etc.* The deterioration of natural resources is a universal threat. India is considered as one of the most risk-prone nations and vulnerable to climate change impacts, water scarcity and declining soil fertility through land degradation [7]. Among the natural resources, soil is a finite, non-elastic and non-renewable asset [1]. It is estimated that around 60 percent of the cultivated land subjected to soil erosion, waterlogging, and salinity and also estimated that between 4.7 and 12 billion tons of top soil are lost annually due to soil erosion. The dwindling per capita availability of land that decreased reduces from 0.5 ha in 1950-51 to 0.15 ha in 1999-2000 and likely to reduce further to 0.08 ha in 2020 AD because of population escalation [1]. Conversion of farmland and forests to urban development reduces the amount of lands available for food and timber production [6]. As per the land use statistics 2014-15, total geographical area of the country is 328.7 million hectares. And of total geographical area, net sown area is 140.1 million hectares and the gross cropped area is 198.4 million hectares with a cropping intensity of 142 percent. The net area sown works out to be 43 percent of the total geographical area. The net irrigated area is 68.4 million hectares. Continued and excess application of chemical inputs and erosion due to wind and water have made our soils unproductive and nearly unfit for cultivation of crops. The majority of the world's soil resources are in only fair, poor or very poor condition and that conditions are getting worse in far more cases than they are improving. Further, 33 percent of land is moderately to highly degraded due to issues like erosion, salinization, compaction, chemical pollution and acidification of soils [3]. Every year erosion carries away 25 to 40 billion tonnes of topsoil, significantly reducing crop yields and the soil's ability to store and cycle carbon, nutrients, and water. In India, soil degradation is estimated to be occurring on 147 million hectares (Mha) of land, including 94 Mha from water erosion, 16 Mha from acidification, 14 Mha from flooding, 9 Mha from wind erosion, 6 Mha from salinity and 7 Mha from a combination of factors [2]. The annual consumption of fertilizers, in nutrient terms (N, P & K), has increased from 0.07 million MT in 1951-52 to more than 25.95 million MT in 2016-17 and per hectare consumption, has increased from less than 1 Kg in 1951-52 to the level of 130.8 Kg in 2016-17. Fertilizers are used almost by all the farmers. India is the second largest consumer of fertilizers in the world after China, consuming about 26.5 million tonnes [8]. It accounted for 15.3 percent of the world's 'N' consumption, 19 percent of phosphatic (P) and 14.4 percent of potassic (K) nutrients in 2008 [5]. Total nutrient consumption ($N+P_2O_5+K_2O$) increased from a total of 25.95 million metric tonnes during 2016-2017 to 26.79 million metric tonne during 2017-2018. 'Nitrogen' consumption at 17.17 million metric tonnes, 'Phosphorous' at 6.84 million metric tonnes and 'Potash' at 2.78 million metric tonnes at a recorded increase of 2.6 %, 2.0% and 10.8 % respectively during 2017-18 over the previous year [4]. The use of chemical fertilizers has become an integral part of the Indian agriculture from the view point of improving yield. In due course, this type of pressure would leave the land unproductive. Unless corrective measures are taken, this will make the damage to the environment and the very resource base irreversible. In our country, the over exploitation of the natural resources and consequent environmental degradation first affects the life of the people who depend on these natural resources for their life. Several studies confirmed that the hilly tribes are the first victims on such issues. In south India, more such environmental degradation hampers the life of the hilly tribal population, more specifically the tribes of the Nilgiri district, Tamil Nadu.

In the Nilgiris district, the tribal population constitutes 4.5 % of the total population and there are six types of tribes living in this district. As it is a hilly resort, the tribes are most affected owing to the fast urbanization and fast growing tourism industry. Hence, the present study has been carried out in the Nilgiri district of Tamil Nadu with the major objective to document the soil related environmental issue and awareness and perception level of the local hilly tribes on the factors responsible for such issue.

Material and Methods

The present study has been carried out in The Nilgiris district of Tamil Nadu. The district comprises of four blocks and all the four blocks were selected. From each block one village was selected considering the maximum tribal households. It is decided to select 10.00 percent of the total tribal households as sample and hence the sample size for the study is fixed as 214 respondents by employing proportionate random sampling.

The study has the following five major components.

1. Documentation the environmental issues
2. Identifying the causes for the documented environmental issues
3. Preparing the perception statements
4. Studying the awareness and perception level of the respondents
5. Studying the degree of acceptance of the sustainable environmental saving practices by the respondents.

By having elaborate discussion with local hilly tribes, local environmentalists and social workers five major causes were enumerated for the documented environmental issues. Based on these major causes perception statements were made. Awareness of the respondents was studied on the each identified issues on two response categories 'aware', 'not aware' with the score of 2 and 1. The perception of the respondents was also studied with four response categories 'Strongly agree', 'Agree', 'Disagree' and 'Undecided'. Again, by adopting the interaction and discussion with the local environmentalists, crop scientists and social scientists, ten sustainable soil management practices were finalised on which the acceptance level of the respondents was studied on three response categories such as 'Fully', 'Partially' and 'Not at all'. Ex post- Facto design was used for the present study. Data were collected using structured and standardized interview schedule. Percentage analysis was done to get meaningful interpretation of the results

Results and Discussion

The results of the study are presented in the following three sub heading.

1. Awareness of the respondents on the soil related environmental issues
2. Perception of the respondents on the soil related environmental issues
3. Degree of acceptance of the respondents on the sustainable soil management practices

Awareness of the respondents on the soil related environmental issues

There were five major issues identified and the distribution of the respondents according to their awareness level on the soil related environmental issues are given in [Table-1].

Table-1 *Distribution of the respondents based on their awareness on soil related issue, (n=214)*

Soil related issues	Aware		Not aware	
	Number	%	Number	%
Loss of soil fertility	209	97.7	5	2.3
Loss of soil beneficial microbial activities	120	56.1	94	43.9
Subsoil compactness	87	40.7	127	59.3
Incidence of frequent soil erosion	181	84.6	33	15.4
Soil become unsuitable for a profitable crop	158	73.8	56	26.2

Nearly cent percentage of the respondents (97.70 percent) were aware about the loss of soil fertility. Most of the respondents (84.60 percent) were well aware about of the incidence of frequent soil erosion. A vast majority of the respondents (73.80 percent) were aware that the native soil becomes unsuitable for a profitable crop. Majority of the respondents (56.10 percent) were aware about the loss of soil beneficial microbial activities followed by about forty percentage of the respondents (40.70 percent) possessed awareness on the environmental issues of subsoil compactness. From the above findings, we could understand that about sixty percentage of the respondents were not aware about the issue of subsoil compactness followed by loss of soil microbial activities. The subsoil compactness was felt as a major soil related environmental issues by the local environmentalists, extension functionaries. This subsoil compactness was due to more of tourism promotional activities and more vehicular intrude in the locality. This issue will affect the soil physiological activities and consequently leave the crop stunted. Similarly, the loss of soil microbial process due to the frequent application of chemical inputs will also affect soil physiological properties. The extension functionaries should take adequate steps to sensitize the tribes about this issue and educate them on the management strategies.

Perception of the respondents on the soil related environmental issues

The findings related to the perception of the respondents on the soil related environmental issues are presented in the [Table-2]. Majority of the respondents (63.10 percent) were of strong opinion that the indiscriminate application of chemical fertilizers leaves the soil sterile. About one fourth of the respondents (23.70 percent) have agreed for this. Only a meagre percentage of the respondents were fell in the other response categories. Nearly half of the respondents (47.20 percent) have strongly agreed that the frequent soil erosion is caused by loss of natural vegetation, whereas, 29.00 percent have agreed for this. Anyhow, 37.85 percent of the respondents stated that they are undecided about this issue which may be due to their lack of awareness. It is observed from the above table that 36.00 percent of the respondents were of the strong opinion that the loss of beneficial microbial activity is basically due to repeated application of chemical inputs beyond the recommended level. Here, 17.30 percent of the respondents have agreed with this fact and 36.26 percent of the respondents were undecided about the issues and causes mentioned in this statement and this may be due to their lack of awareness about this issue. Mono cropping was the major issue which make the soil unfit for raising profitable crop. Here, 30.80 percent of the respondents have strongly agreed this fact whereas 40.70 percent have just agreed this fact. Little more than one fourth of the respondents (22.43 percent) were undecided on this. Subsoil compactness was another issue affecting the crop growth. Here about one fourth of the respondents (24.80 percent) have strongly agreed that the use of heavy farm machineries results subsoil compactness whereas, 15.90 percent have just agreed for this. A considerable perception of the respondents (45.79 percent) were undecided about this issue.

Degree of acceptance of the respondents on the sustainable soil management practices

Findings pertinent to the degree of acceptance of the sustainable soil management practices are presented in the [Table-3]. It has been suggested to grow cover crops in the slopes having more gradients which may naturally avoid the problem of soil erosion. Here, most of the respondents (84.60 percent) have fully accepted this recommendation and the remaining 15.40 percent of the respondents have partially accepted. The application of green manure and green leaf manure in the field to enhance the microbial activity and promote the soil fertility has been suggested and this recommendation was fully accepted by majority of the respondents (71.50 percent) and partially by little more than two fifth of the respondents (28.50 percent). Practicing crop rotation will maintain the soil health and nutrient balance. This practice was fully accepted by majority of the respondents (68.20 percent) and 31.80 percent of the respondents have partially accepted this recommendation. Wider adoption of mulching practices was suggested to control soil erosion which was fully accepted by majority of the respondents (67.80 percent) and partially accepted by 32.20 percent of the respondents. Continuous mono cropping makes the soil sterile / unproductive and thence it was suggested not to follow mono cropping. This was fully accepted by 66.80 percent of the respondents and 33.20 percent have partially accepted. It has been suggested to plant legume crops in order to improve soil structure, enhance the Nitrogen fixation, improve water holding capacity of the soil and stimulate the soil biological property. Majority of the respondents (65.90 percent) have fully accepted this recommendation followed by 34.10 percent of the respondents who have partially accepted.

Table-2 *Distribution of the respondents based on their perception level about the soil related environmental issues, (n=214)*

SN	Soil related issues	Strongly agree		Agree		Disagree		Undecided	
		Number	%	Number	%	Number	%	Number	%
1	Indiscriminate application chemical leaves the soil sterile	135	63.08	55	25.7	13	6.07	11	5.14
2	Repeated application of chemical inputs beyond the recommended level is the reason for loss of soil beneficial microbial activity	77	35.98	37	17.3	1	0.46	99	46.26
3	Use of heavy farm machineries results in the subsoil compactness	53	24.76	34	15.9	11	5.14	116	54.2
4	Frequent soil erosion is caused by loss of natural vegetation	101	47.2	62	28.97	3	1.4	48	22.44
5	The soil become unsuitable for profitable crop because of the loss of soil nutrients which is caused by mono cropping	66	30.84	87	40.65	13	6.07	48	22.44

Table-3 *Distribution of the respondents based on their degree of acceptance of the sustainable soil management practices, (n=214)*

SN	Sustainable practices	Extent of acceptance					
		Fully		Partially		Not at all	
		Number	%	Number	%	Number	%
1	Legume planting	141	65.9	73	34.1	-	-
2	Reducing cropping intensity	129	60.3	85	39.7	-	-
3	Practicing crop rotation	146	68.2	68	31.8	-	-
4	Green manure / Green leaf manure	153	71.5	61	28.5	-	-
5	Avoiding mono cropping	143	66.8	71	33.2	-	-
6	Judicious integration of chemical and organic soil inputs	110	51.4	104	48.6	-	-
7	More use of traditional tillage implements (avoiding the use of heavy machineries)	120	56.1	94	43.9	-	-
8	Wider adoption of mulching practices in order to control soil erosion	145	67.8	69	32.2	-	-
9	Growing cover crops in the slopes having more gradients	181	84.6	33	15.4	-	-
10	Adopting recommended Integrated Nutrient Management practices	133	62.1	81	37.9	-	-

Integrated Nutrient Management practices also one of the recommended practices. Here, little more than three fifth of the respondents (62.10 percent) have fully accepted and nearly two fifth of the respondents (37.90 percent) have partially accepted. It has been recommended to avoid heavy machineries which results in sub soil compaction which affects crop growth and water infiltration. Hence, more use of traditional tillage implements was suggested. More than half of the respondents (56.10 percent) have fully accepted this recommendation and more than two fifth of the respondents (43.90 percent) have partially accepted this. Further, around half of the respondents (51.40 percent) have fully accepted the recommendation of judicious integration of chemical and organic soil inputs and the remainders (48.60 percent) have partially accepted.

Conclusion

The considered proportion of the respondents were not aware of the loss of soil beneficial microbial activity and subsoil compactness in their native soil. They were also not very much aware about the decreasing trend of soil capacity to produce a profitable crop. Even though the respondents have good level of perception on the listed out perception statement, a considerable people of the respondents were very much undesirable about the following issues.

- Loss of soil beneficial microbial activity due to the repeated application of chemical inputs beyond recommended level
- Subsoil compactness due to use of heavy machineries
- Frequent soil erosion by loss of natural vegetation
- Mono cropping makes the soil unproductive

Even though majority of the respondents have fully accepted the listed-out soil management practices, about thirty to forty percentage of the respondents have only partially accepted.

Application of research: Necessary extension education strategies may be developed and promoted among the hilly tribes in line with the observation as noticed above so as to ensure fullest acceptance and adoption of renewable practices in order to maintain a healthy soil ecosystem in the study area.

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