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Evidences and Implications of Socioeconomic Factors Influencing Soil Reclamation Measures

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Abstract
Soil quality can be thought of as a stock of capital which affect the livelihood of rural population through agricultural practices as farmland offers food and income. Soil degradation is responsible for converting fertile agricultural lands into unproductive barren lands reducing productivity causing economic loss to the farmer and food insecurity. Soil alkalinity is one such major form of degradation and causes up to 84.10 per cent of yield loss depending on intensity. In this context a study has been conducted to assess the farmer's response to various exogenous factors as well as socio-economic situation towards maintain or augmenting stock of soil quality. For the study, Manikandam block is selected purposively as 24 per cent of the cultivated area is degraded out of which 64.80 per cent of the land degradation is due to alkalinity. 90 respondents spread over in 5 villages, were randomly selected representing 45 from each stratification namely, farmers adopting reclamation measures in alkaline soil and farmers without adopting reclamation measures in alkaline soil. Prinicipal Component Analysis and Discriminant Analysis were employed to analyse the socio-economic factors influencing adoption of soil reclamation measures to draw suitable policy implication. The results of the above analyses indicate that the institutional factors (0.997) have positive impact on decision towards reclamation whereas economic factors (-0.394) have negative impact towards reclamation measure and it also suggest the importance of awareness creation through intensified extension system and farmer-centric government policies on soil conservation.
Keywords: Alkalinity, Soil Reclamation, Socio-economic Factors, PCA, DA

1.Introduction

Land is the most valuable natural resource for production of food, fibre, fuel and many other essential goods required to meet human and animal needs. Even now 90 per cent of the food production comes from the soil and less than 10 per cent from inland water and ocean (Kulkarni, 2007). Farm profits will be based upon yield outcomes, which in turn will be related to the level of soil quality. Land degradation diminishes the area of quality land available for agriculture and it also result in greater yield variability, and thus greater costs to risk-averse farmers. Generally, more highly degraded lands result in lower productivity, although the impacts vary across production conditions and the production technologies employed. Lower productivity can be due either to decreasing yields or increased production costs associated with decreased input efficiency. Severely degraded lands are mostly inhabited by marginal farmers and tribal populations, who are poor and less literate. Thus land degradation will affect the economic sustainability of the farmer.

The population of India, which is around 1.2 billion at present, is expected to rise to 1.39 billion by 2025. Population in urban area will increase from present level of 28 per cent to about 37 per cent. For meeting this burgeoning requirement of the population, the country will require to produce 320 m.tonnes of food grains by 2025 and 581 m. tonnes by 2050 to achieve marginal self-sufficiency. But the problem is that agricultural production is not increasing in pace with the population growth. Increasing population, urbanisation and industrialisation are affecting both qualitative and quantitative dimensions of land. Due to continuous increase in population, the per-capita land availability has decreased from – ha to – ha from 1960 to 2010. In India where only around 46 per cent of the land area is under agricultural uses. Soil alkalinity is one such major form of degradation , around 12 per cent of land degradation throughout the world is due to alkalinity, (Dagar, J.C. 2005). Soil alkalinity causes up to 84.10 per cent of yield loss depending on intensity (Joshi, 1987). About 8.5 m. ha of cultivated soils in India were affected by alkalinity and salinity and about 11 per cent of irrigated agricultural land was under alkalinity (Roma, 2008). Extending the land under cultivation and improving the productivity of the soil through reclamation is an alternative to intensive agriculture. With more intensive agriculture, there has been a rising stress on natural resources in parts of the country. Thus the reclamation of degraded land and land under degradation is the ultimate hope to increase the food production in pace with growing population to get sustainable self-sufficiency. Thus the economic instability of farmer due to soil alkalinity can be reduced and lead towards stability with adoption of soil reclamation.

The driving forces of land degradation are biophysical, socio-economic (Lu, D. et al. 2004) and political issues (Eswan et al. 2001). Land degradation is not only an environmental issue but also a socio-economic problem (Liu, Y. et al. 2003) and results from intricate relationship between nature and society at all scales (Qi and Cai, 2007). Daba (2003) reported that the socio-economic situation of farmers affects their capabilities to implement environmentally viable soil and water conservation measures. These situations include farm practices and farmers' attitudes toward rational use of resources. Likewise, land reclamation is a technology that must be implemented by the farmers with degraded land. Implementation of land reclamation depends upon decision of the farmer. Troung and Yamada (2002) also have found that socio-economic factors trigger adoption of new technologies by farmers. Without understanding factors influencing soil reclamation, sustainable management of soil resources is impossible. Under this background, this study was conducted with the objective of identifying the socio-economic factors and institutional influencing the farmer's adoption of soil reclamation measures.

2.Methodology

As alkaline soil poses a high risk over food security in India, the socioeconomic factors influencing the adoption of reclamation measures must be studied to help the policy makers. To study the socio-economic factors influencing land reclamation, Principal Component Analysis (PCA) and Discriminant Analysis (DA) were applied utilising the socio-economic data of the sample farms collected during the survey. Though farmers have positive perception of technology, they face problems in technology adoption due to lack of capital, lack of direction from the government and extension officials, lack of compensation policy to ensure loss of yield. Besides, farmers' poverty might reduce their willingness of making investments as the return to investments is often low on a short-term basis, (Boetekees, 2002). The decision on soil reclamation depends on socio-economic factors like age, education, secondary occupation of farmer, house-hold income, his contact with extension workers, availability of irrigation facilities and so on. Any change in either one will influence the other. Moreover, Bewket (2007) reported that awareness of risk and its causes could influence farmers' intentions to adopt soil conservation practices while its actual adoption depends on socio-economic and institutional factors.

The variables used in the present study has been described in Table 1.

Southavilay, et al. (2012) has used socio-economic factors such as farmer's age, farm size, level of education, household size, farming experience, source of credit and seed variety as explanatory variables in their study. Troung and Yamada (2002) have also used age, education, size of farm holding, weather, capital availability as variables in their study on adoption of new technology. Government policies and programmes also play a crucial role in affecting farmer's decisions with regard to land management (Boetekees, 2002). The National Agricultural Development Programme (NADP) has given inputs for reclamation of alkaline soil at subsidised prices to the farmers through agricultural office in the study area and hence the contact of the farmer with extension department was also used as a variable in the study.

Principal Component Analysis (PCA) is one of the statistical procedures in Factor Analysis. The purpose of PCA is to derive a relatively small number of components that can account for the variability found in a relatively large number of measures. Factor analysis allowed the identification of the most important cognitive aspects that influence soil conservation decisions and the construction of consistent indices. Factor analysis is a collection of methods used to examine how underlying constructs influence the responses on a number of measured variables. Factor analyses are performed by examining the pattern of correlations (or covariances) between the observed measures. Measures that are highly correlated (either positively or negatively) are likely influenced by the same factors; while those that are relatively uncorrelated are likely influenced by different factors. Therefore, factor analysis was used in the present study to factor out the most correlating variables towards adoption of reclamation measure and those variables would be passed on to the discriminant analysis.

According to Babu and Sanyal (2009), each variable for PCA was categorical as the statistical method was described. PCA studies the inter correlation between the ariables and creates a correlation matrix called rotated component matrix. The resultant R-matrix must not be an identity matrix. Kaiser-Meyer-Olkin (KMO) and Bartlett's Test confirms the sampling adequacy of the data and assures that the R-matrix is not an identity matrix.

In this research, linear Discriminant analysis between socioeconomic characters of farmers adopting and non-adopting reclamation measures was performed. Similarly Daba (2003) has used discriminant analysis to study on the perception of farmers about their willingness to adopt new improved soil and water conservation measures. A discriminant function, also called a canonical root, is a latent variable which is created as a linear combination of discriminating (independent) variables, to classify cases into one of several mutually exclusive groups based on their values for a set of predictor variables. The grouping variable must be categorical, and the independent (predictor) variables must be interval or dichotomous, since they will be used in a regression-type equation.

General Algorithm: $\text{Group} = a + b_1*x_1 + b_2*x_2 + ... + b_m*x_m$

where a is a constant and b_1 through b_m are regression coefficients.

The interpretation of the results of a two-group problem follows the logic of multiple regressions.

Those variables with the largest correlation coefficients are the ones that contribute most to the prediction of group membership. Eigen value measures such a proportion of variance. Similarly, Wilk's lambda exhibits the proportion of the total variance in the discriminant score not explained by differences among the groups. Variance between the groups, alkaline soil with reclamation and with-out reclamation is a must to study the influence of socio-economic factors on adoption of reclamation measures.

$$Y= \beta_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_jX_j$$

Y = 1, Farmer adopting reclamation measures

0, otherwise

b_1 to b_{12} = parameters to be estimated; β_0 = constant

$X_{1...}$ X_j – Socio economic variables selected after the correlation study under Principal Component Analysis.

3.Study Site and Sampling:

The study area is located in Tamil Nadu. Tamil Nadu ranks first in the area under alkalinity in south India and the state has been purposively selected for the study. According to Natarajan et al. (2009) about 17.60 per cent of the total land area of the state had degraded soil. Sodicity alone caused around 11 per cent of land degradation. Among the 23 districts of Tamil Nadu which were affected by soil alkalinity, Tiruchirapalli district was randomly selected for the study. Tiruchirapalli, which is one of the districts with large area under alkalinity, has 12 blocks. Manikandam block is the most problematic block contributing for 42 per cent area affected by alkalinity in the district, and hence this study was conducted in Manikandam block. The block receives government support for reclamation of alkaline soil through National Agricultural Development Program (NADP) in the form of subsidised reclamation inputs. Alkaline area was present in patches throughout the block. Out of the 22 villages in Manikandam block, five villages namely, Olaiyur, Mullipatti, Thirumalaisamudram, Ariyavur and Poongudi were randomly selected for the study. Data were collected from 90 farmers comprising, 45 farmers who adopt reclamation and 45 farmers who do not adopt these measures.

4.Results

Identification of the socio-economic and institutional factors affecting alkaline soil reclamation is useful not only to better understand the relationship between socio-economic drivers and alkaline soil reclamation but also to formulate better strategies and appropriate policies for addressing the issue of alkaline soil reclamation, (Southavilay, et al. 2012). Principal Component Analysis (PCA) was used to initially factor out the 11 socio-economic variables based on their relation on decision making. PCA helps to select the most influencing factors for Discriminant Analysis. The ratio of cases to variables in a principal component analysis should be at least 5 to one. In the present research, the ratio of cases to the variables was 5.45 to one. In addition, the overall measure of sampling adequacy (MSA) for the set of variables included in the analysis was 0.713, which exceeded the minimum requirement of 0.50. Principal Component Analysis requires the probability associated with Bartlett's Test of Sphericity be less than the level of significance. The probability associated with the Bartlett test is <0.001, which satisfied this requirement. Thus the model was quite fit to the variables.

Rotated component matrix is a matrix of factor loadings for each variable into each factor. To sort out the most influencing variable for discriminant analysis, all the variables which are significant with a value more than 0.50 are selected from the Rotated component matrix (Table 2). Variables found significant in more than one component must not be used for further analysis. In this research there were no such variables as is evident from (Table 2). Variables such as irrigation (0.942), cost of reclamation measures (0.966), and awareness of reclamation measures (0.890), reclamation scheme availability (0.864) exerted high positive significance towards adoption of land reclamation. The variable Irrigation represented the availability of irrigable water. Variables such as age of the farmer (-0.530) and intensity of alkalinity (-0.539) were negatively significant towards adoption of land reclamation. Secondary occupation of farm households (0.768) had a positive influence on adoption of reclamation measure. Farmers, linkage with the Agricultural Extension Department was important in increasing the adoption of reclamation measures. Awareness must also be created to increase the adoption of reclamation. All the variables in rotated component matrix had a value of more than 0.5; and hence all the variables were considered for the discriminant analysis.

Education of the farmer (0.603) influenced positively and increased the adoption of reclamation measures. The percentage of farmers who attended secondary, higher secondary and collegiate education was more under soil reclamation group than unreclaimed alkaline soil condition. It is similar to the reports given by Carlson et al. (1977); Ervin and Ervin, (1982); Traore et al. (1998); Mbaga-Semgalawe and Lambert et al. (2007) that education is related to knowledge on consequences of soil management practices and alternative solutions, which in turn influences behaviour. Educated farmers have awareness on the importance of adopting soil reclamation practices, understanding that soil productivity can be degraded if appropriate actions are not initiated.

Based on the above PCA result data reduction can be done by grouping the variables under various

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components and naming them accordingly (Table 3).

Discriminant function analysis was used to identify the variables responsible for adoption and non-adoption of reclamation measures by sample farmers. All the socio-economic variables had exhibited correlation towards adoption of reclamation measures in Principal Component Analysis. Hence, all the ungrouped socio-economic variables can be used in Discriminant Analysis or newly grouped variables can also be used for Discriminant Analysis. In the present study, Discriminant Analysis was applied on grouped as well as ungrouped variables separately.

The Eigen value of both the analysis was larger and a large Eigen value is associated with a strong function. A high correlation indicates a function that discriminates well. A small Wilk's lambda value indicates that group means appear to differ. The associated significant value of Wilk's lambda indicates whether the difference is significant. In both Discriminant Analysis, the Lambda value was small and had a significant value (Sig. = 0.000); thus, the group means appeared to differ.

The result of Discriminant Analysis(structure matrix) was presented in (Table 4). It gives the coefficients of correlation between independent variables and discriminant function. Any predictor with a score of more than 0.30 is considered to be an important discriminating factor. In structure matrix, variables are ordered by absolute size of correlation within the function. The interpretation of the discriminant coefficients (or weights) was like that of in multiple regression. The sign indicates the direction of the relationship. Karl Wuensch. L (2008) stated that these coefficients reflect the contribution of one variate in the context of the other variates in the model.

From the above result of Discriminant Analysis using ungrouped variables (Table 4) it is evident that reclamation scheme availability(0.637), linkage with extension department (0.617), awareness about reclamation measures (0.519) were the major socio-economic factors influencing towards adoption of reclamation measure in Tiruchirapalli district. Using the results of Discriminant Analysis using grouped variables (Table 5) it can easily be proved that institutional factors (0.997) play a major role in adoption of reclamation measures by the farmers. Government schemes for soil conservation, subsidised reclamation input availability and awareness programs increase adoption decision by farmers towards soil reclamation. The economic factors though meagre has negative effect on decision towards soil reclamation. When cost of reclamation and intensity of alkalinity increases farmer will not adopt reclamation measure. Solomon et al. (2007) found that wealthier households were able to invest in soil fertility management while the poorer households were mining nutrients in soils.

5.Conclusion

Thus research has found that the important factors responsible for adoption of reclamation measures, are cost of reclamation measure, awareness about incidence of alkalinity and soil reclamation, availability of inputs for reclamation, linkage with department of agriculture and irrigation sources. According to Ervin and Ervin (1982) farmers are often aware of the condition of their land, but they may not be fully aware of land degradation, its causes and its consequences. Besides off-farm income and wealth, age of the household head and participation in other soil and water conservation programmes are important discriminant variables (Boetekees, 2002).

According to Barrett, et al. (2002) several priorities emerge concerning policies on improving smallholder natural resource management practices like soil and water conservation measures. Hence, top-down approaches should be replaced with farmer-centred approaches in order to spur rapid and widespread adoption. Such farmer-oriented approaches take into account the broader livelihood objectives of rural people, which are primarily geared towards coping with a high degree of uncertainty, minimising risk and meeting subsistence needs, rather than maximising production and profits. Furthermore, learning processes have to become central to the cycle of developing, disseminating and evaluating new methods. Hence, information flows and access to and quality of education in rural Tamil Nadu have to be improved. Extension services must be improved to increase the farmer's awareness towards soil testing and the technology of soil reclamation. Even number of irrigation source also affects the adoption of reclamation measures; hence better irrigation source accessibility must be created. Finally, it is understood that the adoption of improved natural resource management techniques occurs as a result of decisions made by a wide range of people, each influenced by the incentives and the constraints they face. Necessary public investments and policy reforms must therefore be undertaken to reduce the structural impediments that discourage investment in improved natural resource management.

All schemes / policies should be focused towards enhancing the household technical efficiency in agricultural activities. This in turn will ensures sustainability of livelihoods and improves environment and peoples' welfare. As output increases, households will meet their twin demand – food security and income with less extent of environmental resources degradation and achieving a win – win situation as far as reclamation and development goals are concerned. Investment on land and water must be viewed as investment on sustained food security, income, prosperity and environmental health. Development of degraded lands in India is one of the options available to enhance food production and to restore the fragile eco-system.

Table 1 Description of Variables

List of variables	Particulars of Variables	Characteristics of Variables
X_1	Age of Farmer	Discrete value
X_2	Education of Farmer	Continuous value
X_3	Reclamation Scheme Availability	1= yes; 2=no
X_4	Secondary Occupation	1= yes; 2=no
X_5	Number of Irrigation Sources	Only 1 kind of source = 1; 2 kind of sources = 2; 3 kind of sources = 3
X_6	Cost of Reclamation measure	Not-aware = 0; Low = 1; Medium = 2; High = 3
X_7	Input Availability	Low = 1; Medium = 2; High = 3
X_8	Linkage with Agricultural Extension Department	No = 1; Fair = 2; Medium = 3
X_9	Intensity of Alkalinity	Low = 1; Medium = 2; High = 3
X_{10}	Farmer Holding both Alkaline and Non-alkaline Land Area	Only alkaline =1; Alkaline and non-alkaline = 2
X_{11}	Awareness towards Reclamation Measures	1= yes; 2=no

Table 2 Result of Principal Component Analysis

S.No	Socio-economic variables	Component			
		1	**2**	**3**	**4**
1.	Age of farmer	0.428	0.227	**-0.530**	-0.166
2.	Education of farmer	0.374	0.056	**0.603**	0.455
3.	Secondary occupation of farmer	0.194	0.047	**0.768**	-0.117
4.	Farmer holding both alkaline and non-alkaline area	0.022	0.055	**0.690**	0.058
5.	Reclamation scheme availability	**0.864**	0.039	0.064	-0.120
6.	Awareness towards reclamation measures	**0.890**	0.302	0.094	-0.018
7.	Cost of reclamation measures	-0.108	**-0.966**	-0.036	-0.054
8.	Linkage with Agricultural Extension Department	**0.785**	0.295	0.130	0.099
9.	Intensity of alkalinity	-0.074	**-0.539**	-0.109	-0.277
10.	Input availability	**0.744**	-0.098	0.018	0.029
11.	Number of Irrigation Sources	0.027	-0.081	0.025	**0.942**

Table 3 Grouping of variables

Component	Variables	Name
1	• Reclamation scheme availability • Awareness towards reclamation measures • Linkage with Agricultural Extension Department • Input availability	Institutional
2	• Intensity of alkalinity • Cost of reclamation measures	Economical
3	• Farmer holding both alkaline and non-alkaline area • Secondary occupation of farmer • Education of farmer • Age of farmer	Sociological
4	• Number of Irrigation Sources	Irrigation

Table 4 Result of Discriminant Analysis using Ungrouped variables

Socio-economic Variables	Coefficients of Adoption
Reclamation scheme availability	0.637
Linkage with Agricultural Extension Department	0.617
Awareness towards reclamation Measures	0.519
Education of Farmer	0.436
Input availability	0.434
Intensity of alkalinity	-0.286
Secondary Occupation of Farmer	0.278
Number of Irrigation Sources	0.268
Cost of reclamation measures	0.146
Age of Farmer	0.118
Farmer holding both alkaline and non-alkaline area	-0.050

Table 5 Result of Discriminant Analysis using Grouped variables

Socio-economic Variables	Coefficients of Adoption
Institutional	0.997
Economical	-0.394
Irrigation	0.060
Sociological	0.041

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