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Social Capital and Soil Erosion Control in Agriculturally Marginal Areas of Kenya: The case of Machakos and Taita-Taveta Districts

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Abstract: This paper evaluates the farmers' perception of the soil erosion problem, and identifies and analyses social capital elements that motivate households to actively participate in soil conservation in agricultural production process. The data used in the study was generated using a structured questionnaire in a survey that covered 321 households in Kenya's semi arid districts of Machakos and Taita-Taveta Districts. Two modelling strategies were used: A Probit model was used to estimate the likelihoods of factors that may influence farmers' perception of soil erosion problem, and a Tobit to estimate parameters of factors that influence terracing intensity. The results indicate that although perception of the soil erosion problem is relatively high in the study sites, its effect on soil conservation investments is not significant. In Machakos, the significant determinants of terracing intensity include land tenure, crop area, household size, and membership diversity whereas in Taita-Taveta they include age of household head and consumer-worker ratio. Results from the aggregated data show that lagged crop output, group membership density and diversity, cognitive social capital and location significantly influence the terracing intensity on farm household fields. The policy challenge is to establish and strengthen social capital elements that have a strong influence on communities undertaking soil erosion control measures for sustainable agriculture and rural development..
Key words: Social capital; Marginal areas; Soil erosion; Perception; Two-step estimation; Kenya.
JEL: C24, D23, Q15, Z13

Introduction

Land degradation and declining agricultural productivity are often attributed to the traditional land tenure systems of managing agricultural land. Among the indicators of land degradation is soil erosion[1]. Farmers depend upon land for their livelihoods and as Scherr (1999) argues, it is uncommon for them to be unaware of serious soil degradation unless they are recent immigrants to a new agro-ecological zone, the process of degradation has not yet affected yields, or its cause is invisible. Invisibility of soil erosion can be discounted because it's a visible indicator of soil loss.

In Kenya, most resource poor groups in rural areas are concentrated on low potential lands where inadequate or unreliable rainfall, adverse soil conditions, fertility, and topography limit agricultural productivity and increase the risk of land degradation. The attempts of such groups to improve their livelihoods often lead to over-exploitation of land and water resources. Given these facts, resource management by poor households is crucial in dealing with the development and poverty problems facing Kenya.

Land degradation in Kenya, as in most other developing countries, manifests itself in rapid rates of natural capital depletion, exemplified by forest degradation and soil erosion especially in river basins. The situation is worse in the marginal lands (which constitute about 80 percent of the total agricultural land) where there is serious environmental deterioration largely due to increasing human and animal pressure. These areas are faced with frequent food shortages, are ecologically vulnerable and receive irregular and low amounts of rainfall. They also face serious problems of environmental degradation such as soil erosion and soil mining. While efforts have been

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[1] Other forms of soil degradation are damages to physical and chemical properties of soil, reduction in moisture capacity, and soil mining.

made to motivate land users to efficiently use the land resource, soil conservation been given limited attention in agricultural policy. Even less considered is social capital.

In the traditional African setting, it has been argued that individuals are generally social and that the level of social interaction in all spheres of life is relatively high. Such interaction can be captured from a social perspective in social capital and subjected to empirical analysis from an economic context. We argue that if soil erosion presents a potential threat to an individual's livelihood the society will be concerned and that it will mobilize resources to mitigate any negative impacts that may arise. While the importance of social capital has long been recognized in other social sciences (see e.g. Coleman 1988; Putman, 1995; and Granovetter, 1985), it has only recently received attention in the economics literature (e.g. Narayan and Pritchet, 1997; Knack and Keefer, 1997; Temple and Johnson, 1998; Grootaert, 2001; Haddad and Malucio, 2002; and La Ferara, 2002; Uphoff and Wijayaratina, 2000, among others) it has had minimal reference in economics. This is particularly true in so far as production and soil resource management in the agricultural sub-sector of an economy is concerned.

Agricultural production is often defined by the level of conventional inputs such as physical capital and labour employed in the process but social capital can compliment the process if only as an arbiter of transaction costs. High transaction costs have been attributed to inadequacy in coverage and quality of rural road infrastructure (Obare et al, 2003, and Omamo, 1998). Social capital should, also, facilitate scale economies in resources that have no market price. Yet it is minimally or never factored into economic analyses that have a bearing on resource use and management especially with respect to the agricultural sub-sector of developing country economies.

There is glaring paucity of information of any rigorous analyses to estimate the contribution of social capital in a marginally agricultural setting in soil erosion control and management in Kenya. For example Frank, et al (2002) analyzed the effect of group structural variables on performance in an activity like tree nurseries in high potential zones of Kirinyaga and Nyeri districts and less favourable zones of Meru and Embu districts, while de Haan, et al (1996) examined the performance of dairy groups in Kenya. In the Philippines Cramb (2004) examines the effect of social capital on terracing in humid tropics. This paper aims to fill this gap using data from a 2003 survey of farming households in selected marginal areas of Kenya. We use a Heckman's two-stage regression to estimate a perception of soil erosion problem sample selection Probit and a least square regression to establish the likelihood of a vector of variables in influencing terracing intensity in erosion-prone and agriculturally marginal areas. A specific feature of the modelling strategy is the incorporation of a farmer specific perception of the soil erosion problem. We argue that any investment in soil erosion control measures will be preceded by the appreciation by individual farmers of the seriousness of the soil erosion problem and that social capital plays a role in sensitization of the problem. The perception and terracing intensity equations reveal possible reasonable impacts of social capital attributes whose policy implications centre on establishing and strengthening those elements that have a positive influence on those communities and households that are undertaking soil erosion control measures.

Methodology

Data

The study areas are in agro-ecological zone IV (see Jaetzold and Schmidt, 1983). This zone is a transition between semi-arid and semi-humid, depending on altitude. It is characterised by having between 115 and 145 growing days (medium to medium/short growing season) and annual mean temperature between 15 and 18^0C in the Lower Highland zone. The Upper Midland zone has between 75-104 growing days (short to very short growing season) and a mean annual temperature of between 21^0C and 24^0C.

The data for this study are a result of a survey of rural households in Machakos and Taita-Taveta Districts conducted in 2003. Four sub-locations were chosen in each district on the basis of terracing density and physical infrastructural endowments such as road network. Two sub-locations with higher terracing density but with higher and lower physical infrastructural endowments were selected in each district. Likewise, two sub-locations with lower terracing density but with higher and lower physical infrastructural endowments were also selected. A village was then selected randomly from each of the sub-locations. The survey instrument was administered to 40 randomly selected households in each village.

The model

The study is conceptualised around the likelihood of adopting soil control measures to mitigate soil problem. We assume that any investment undertaken by a farm household to control soil erosion will depend on the farmer's perception of the seriousness of the soil erosion problem in so far as it affects the household's livelihood. In this case we conceptualize a binary perception outcome: soil erosion is a problem (1) or it is not a problem (0). Depending on the perception outcome an individual farmer is likely to make a decision that will mitigate the consequences of the erosion problem. We anticipate that the outcome of this decision will be observable in soil control measures in a form of terraces. The perception model enables us thus to select a sample that has made investments in terracing. The underlying logic is that an individual cannot invest in terraces in an effort to control soil erosion if the same individual doesn't acknowledge the existence of soil erosion problem. In linking up the two outcomes we assume that acknowledgement of a soil erosion problem precedes an investment decision. Thus any observable terrace investment precedes an "acknowledgement of the soil erosion function." Subsequently the output (i.e. observed terraces) is as a result of a two-step process. Following Greene (2000) consider a model consisting of two equations. The first equation is the "selection equation,"[2] which is defined as

$$z_i^* = w_i'\gamma + u_i, \quad i = 1,\ldots\ldots,N \tag{1}$$

where z_i^* is a latent variable, γ is a Kx1 vector of parameters, w_i' is a 1xK row vector of observations on K exogenous variables and u_i is a random disturbance. The latent variable is unobservable, but we do observe the dichotomous variable

$$z_i = \begin{cases} 1 & z_i^* > 0 \\ 0 & otherwise \end{cases} \tag{2}$$

The second equation is the linear model of primary interest.[3] It is given as

$$y_i = x_i'\beta + e_i, \quad i = 1,\ldots\ldots,n, \qquad N > n \tag{3}$$

where y_i is an observable random variable, β is an Mx1 vector of parameters, x_i' is a 1xM vector of exogenous variables and e_i is a random disturbance. Following Hill, et al, (2003) the disturbances are jointly distributed as

$$\begin{bmatrix} u_i \\ e_i \end{bmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & \sigma_2^2 \end{pmatrix}\right] \tag{4}$$

To avoid a "selectivity problem" a two-step estimation procedure suggested by Heckman (1979) and clarified by Greene (1981) was employed. We estimate a "perception of soil erosion problem" selection Probit and a primary terracing intensity least square regression model in order to draw conclusions on a larger population of farming communities in the study areas. We specify the empirical models as

$$perc = f(ageh01, educ, slope, tenure, faror, memdive, groups, particip, erode, sex, dummyex) \tag{5}$$

and

$$terrace = f(age01, educ, hhs, farmca, maktaccess, slope, tenure, hhicome, faror, memdive, groups, particip, sex, dummyex) \tag{6}$$

The variable description and measurements are presented in Table 1. Since most of the variables presented are self explanatory we briefly discuss the social capital elements that we considered in this study. The elements include: groups, membership diversity, and household participation in group dynamics in a form of decision making – either directly or indirectly. Membership diversity was measured through rating according to five criteria: religion, gender, age, political affiliation, and education. A diversity score was then calculated for each organization, ranging from one to two (A value of one on each criterion indicates that members of the organization are "mostly from the same" religious affiliations, gender and so on; while a value of two indicates they come from mostly different groups). These scores were then summed up per household to generate a

[2] The selection equation in our case is captured by the perception of soil erosion function
[3] This model captures the soil erosion control efforts which in our case is indicated by the terracing intensity

diversity index. This index procedure assumes that each criterion has the same weight in measuring the overall diversity of membership.

Regarding participation, it is generally believed that organizations that follow a democratic pattern of decision-making are more effective than others. This makes us know which ones are more democratic than the others. The two questions (a) respondent evaluation of the relative roles of the leader and the members in reaching decisions and, (b) respondent overall evaluation of the effectiveness of the organization leader; can be combined in a "democratic functioning score" to determine the diversity score namely: 1 = the leader decides and informs the group, 2= the leader asks group members for their views and then decides, 3= the group members hold a discussion and decide together on one hand and 1= the leader is not effective, 2=the leader is somewhat effective, and 3= the leader is very effective.[4] These scores are then added up for each household.

Table 1: Description and measurement of variables

Variable	Description	Measurement
district	Location of study site	Dummy: Machakos=1, Taita-Taveta=0.
age01	Age of household head	Years
hhs	Household size	Number of persons
terrace	Length of terrace	Metres per hectare
slope	Slope of land parcels	Simple scale: 1=low flat, 2=low slope, 3=medium slope, 4=steep slope
tenure	Land tenure security	Simple increasing scale of tenure security (1 to 7)
groups	Number of groups that a household member belongs to	Simple increasing scale
memdive	Membership diversity	Simple increasing scale
particip	Participation in decision-making	Simple increasing scale
educ	Education of household head	Number of years in formal schooling
sex	Sex of household head	1=Male, 0=female
farmsize	Size of the farm	Hectares
faror	Degree of farm orientation	Fraction of off-farm income in total household income
famca	Farm size per capita	Hectares per person
hhincome	Household income	Kenya shillings
hhincomepc	Household income per capita	Kenya shillings
age	Age of household head	Number of years
mktaccess	Access costs to markets	Kenya shillings
erode	Erosion status	1= eroded or 0=not eroded
perc	Perception of soil erosion problem	Problem=1, not a problem=0
dummyex	Contact with extension staff	Yes=1, No=0

Source: Case study household survey

The *groups* variable captures the number of groups in the study areas to which members of a household belong. It is a good indicator of the various sources of information that a household has access to. The variable is computed by the summation of the groups that all members of a household belong to in order to generate a measurable index for the group variable.

Results and Discussions

Household socio-economic characteristics

The descriptive statistics for selected variables are presented in Table 2. They indicate both the disaggregated (by district) and pooled statistics. The average age of the household head in Taita-Taveta district significantly higher

[4] Effective here means that the leader manages and actively participates in mobilizing members in effecting decisions that have been made by the group in addition to being innovative in initiating developing agenda.

(about 52) compared to Machakos district (48 years). The same applies to the mean values of perception of the soil erosion problem (*perc*) and the gender of household head (*sex*). The average values of terracing intensity (*terraces*), farm orientation (*faror*), number of groups (groups), market access (*mktacces*) and soil erosion status (*erode*) variables are significantly higher in Machakos than in Taita-Taveta. The significance of comparative means of variables are indicative of the likely effects that they may have on soil erosion control investments some of which appear to be location specific. Individual perception, and therefore, the subsequent negative effects, would necessarily spur action that would mitigate the effects that would arise from non-intervention. Soil erosion or generally soil degradation is a process that takes a long time for the consequences to be appreciated and only then if those affected are able to directly associate them to that process.

The mean market access costs (*mktacces*) of 107 in Machakos and 90 in Taita-Taveta are significantly different and this should have a bearing on returns from agricultural economic activities in the two study sites yet the household income both in absolute and in per capita terms are not significantly different. Perhaps this would be explained by the existing market for outputs and inputs both temporally and spatially. At least Machakos district has spatially a relatively dense consumption demand sites in the form of Machakos town and even the distance to Nairobi city is small. In Taita-Taveta on the other hand the supply outlets are thin and the nearest high demand market (i.e. Mombasa is relatively far).

Table 2: Descriptive statistics of selected variables

Variable	Machakos			Taita-Taveta			*t*-value[a]
	N	Mean	Std. Deviation	N	Mean	Std. Deviation	
ageh01	146	47.82	14.85	144	51.49	15.02	-2.097**
educ	151	6.82	3.91	105	7.24	3.84	-0.85
terraces	152	951.07	1293.83	144	613.66	2098.68	1.675*
hhs	152	6.03	2.61	144	6.47	2.75	-0.408
Farmca	149	0.35	0.58	144	0.46	0.65	-0.421
mktacces	152	107.17	19.13	144	90.42	36.58	4.974***
slope	149	2.33	0.87	140	2.19	0.85	1.307
tenure	148	5.90	1.24	144	5.85	0.99	0.368
hhincome	152	63162.63	181637.56	140	43537.48	88332.86	1.158
hhincomepc	152	1153.65	27930.00	140	8447.67	22297.19	0.91
farmsize	149	1.98	3.47	144	2.54	3.31	-1.425
faror	152	0.33	0.36	140	0.28	0.36	1.155**
perc	152	0.59	0.49	144	0.74	0.44	-2.757***
memdive	125	14.48	7.24	67	14.03	8.33	0.389
groups	152	1.24	0.91	144	0.72	0.98	4.744***
particip	125	7.53	4.56	67	7.07	3.96	0.686
erode	151	0.89	0.32	143	0.79	0.41	2.286**
Sex	152	0.93	0.26	144	0.80	0.40	3.293***
dummyex	149	0.21	0.41	143	0.34	0.48	-2.599***

Note: Std. means standard; N is the number of respondents
[a] Mean difference test with equal variances assumed
* $P< 0.10$, ** $P < 0.05$ and *** $P<0.01$.
Source: Case study household survey

Household income is a good indicator of the welfare of the affected households. The mean annual household incomes (*hhincome*) in the study areas are about Ksh 63,000 and Ksh 43,000 in Machakos and Taita-Taveta districts, respectively. However, the mean household income per capita (*hhincomepc*) of Ksh 8,448 is higher in Taita-Taveta district compared to Ksh 1,154 that is observed in Machakos district. Although the mean differences are not significant we observe that studied households are seemingly poor when considered against the background that by 1998 the mean value of crop production from farm production alone by poor households in Kenya was about Ksh 3,285 (Republic of Kenya, First Report on Poverty in Kenya – Vol. II, 1998).

The average farm size (*farmsize*) in Taita-Taveta is about 2.5 hectares (ha) compared to Machakos with a mean size of approximately 2 ha. The mean difference is insignificant. The average farm sizes of between 2 and 2.5 ha compare favourably to that of a sample from several districts in the high potential agricultural areas of Kenya by Jayne, et al (1998) which measure 5.9 acres (approx. 2.39 ha) and yet the study sites are found in marginal areas of Kenya. Since the household sizes are more or less similar while the mean farm sizes are relatively different in the two sites it follows therefore that the mean per capita farm size (*farmca*) is also different. The mean farm per capita measures 0.35 ha in Machakos and 0.46 ha in Taita-Taveta.

The mean terrace length per hectare (*terrace*) in Machakos is higher than in Taita-Taveta. This would be due to several potential reasons: First, soil conservation campaigns have been more sustained and intense in Machakos than in Taita-Taveta. Secondly, the income status would have provided an impetus to invest more in terracing although it would also be argued that due to terracing and hence soil conservation, farmers in Machakos District were able to improve their incomes from agriculture. The mean household size (*hhs*) in both sites is 6 members. The mean values of farm slope index (*slope*), education level of household head (*educ*) and the land tenure system (*tenure*) vary although the values are not significantly different in the two. Nevertheless, we expect these variables are likely to have an effect on soil conservation.

Perception of the soil erosion and determinants of terracing intensity

In Table 3 shows the results of the Heckman's two-step regression, following estimation of (5) and (6), for the two sampled sites are presented. The sigma values are greater than zero which shows that the two equations are independent. The Wald χ^2 statistics are significant indicating the rejection of the null hypotheses which posit that the estimated coefficients are equal to zero. The Mills' lambda is significant with respect to the Machakos sub-sample which means that selection is important.

In the dis-aggregated results age of household head (*ageh*01) coefficient is positive only for Taita-Taveta. It is evident, therefore, that in Taita-Taveta the older[5] the household head s/he is likely to acknowledge the soil erosion problem and this perhaps reinforces the need to construct terraces for the sole purpose of reducing soil erosion effects. Another possible explanation is that the older the decision makers the lower their discount rates on investments in new innovations.

Table 3: Heckman's two-step regression results

Variable	Machakos (N=113)		Taita-Taveta (N=45)		Pooled (N=158)	
	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err
	Perception (*perc*) *equation*: *a Probit specification*					
ageh01	-0.004	0.003	-0.007*	0.004	0.0016	0.0046
educ	-0.046***	0.013	-0.009	0.014	-0.0233	0.0166
slope	0.090*	0.051	-0.033	0.060	0.1234*	0.0712
tenure	-0.098**	0.040	0.064	0.062	-0.0642	0.0557
faror	-0.517***	0.113	0.081	0.123	-0.5350***	0.1643
memdive	0.018	0.040	-0.037	0.034	-0.0634	0.0508
groups	-0.396	0.411	0.363	0.344	0.4667	0.4938

[5] Age is a good proxy for farming experience.

particip	0.031	0.030	0.021	0.022	0.0120	0.0294
erode	0.524***	0.141	0.806***	0.110	0.6745***	0.1689
sex	0.007	0.184	0.091	0.111	-0.2327	0.1918
dummyex	-0.228**	0.107	-0.165	0.112	-0.1825	0.1364
Constant	1.354***	0.391	0.165	0.431	0.6116	0.5040
			terraces (*terraces*) *selection equation*			
district					-1.3113***	0.3891
ageh01	-0.021	0.030	0.115*	0.069	0.0259*	0.0138
educ	-0.112	0.110	-0.228	0.221	0.0402	0.0468
hhs	0.691**	0.285	-0.859*	0.456	0.0839	0.0712
farmca	1.250	1.189	-4.988*	2.683	-0.1901	0.2089
mktacces	-0.019	0.018	-0.026	0.017	-0.0032	0.0056
slope	1.111**	0.520	1.194	0.738	0.3756*	0.2024
tenure	0.765**	0.331	-1.599*	0.894	0.1741	0.1355
hhincome	0.000	0.000	0.000	0.000	0.0000	0.0000
faror	-0.492	0.896	-4.166	2.593	-0.4911	0.3951
memdive	-1.106**	0.544	-0.763	0.704	-0.3403**	0.1336
groups	11.055**	5.458	5.635	6.248	3.2036**	1.2876
particip	-0.206	0.212	0.288	0.444	-0.0351	0.0879
erode	1.160	0.820	-1.703	2.186	0.2736	0.3940
sex	-4.483	3.369	-1.806	1.933	-1.2738**	0.6308
dummyex	-1.217	0.749	0.741	0.995	-0.1516	0.3342
Constant	0.107		17.755	11.972	0.8873	1.5373
Mills lambda	-0.370**	0.186	-0.168	0.166	0.6314	0.3064
rho	-0.948		-0.756		1.0000	
sigma	0.390		0.223		0.6314	
lambda	-0.370	0.186	-0.168	0.166	0.6314	0.3064
Wald $\chi^2(22)$	79.91		89.36		49.17	

Note: Std. Err. denotes standard error
*P< 0.10, **P <0.05 and ***P<0.01.

Farm size per capita (*farmca*) has negative and significant effect on terrace intensity in Taita-Taveta district. A possible explanation would be that the bigger land size per capita implies less pressure on land for agricultural activities from the farm household perspective and subsequently there is likely to be less motivation for intensified terracing of farms. The slope of the farm (*slope*) has a positive and significant effect on terrace intensity and particularly in Machakos district. The same effect is also evidenced in the aggregated results. The positive effect observed in Machakos would be as a result of the sustained campaign on soil conservation that has been promoted for a longer time compared to Taita-Taveta district. It is also apparent from the descriptive results that Machakos district is relatively hilly than Taita-Taveta with the result that even without any external influence farmers are likely to undertake measures to control soil erosion. In general it is likely to expect steeply sloping farms to have some terracing activities as evidenced from the pooled results. We also note, however, that the larger farms are likely to have large crop fields. All things being equal, effects of erosive element will develop more on, and be discernible more on larger than smaller field.

The land tenure security variable has a positive and significant effect on the likelihood of observing intensified terracing for soil erosion control in both Machakos and Taita-Taveta districts. This suggests that farm households with insecure land tenure rights are unlikely to make any investments in soil erosion control measures. This finding is consistent with empirical evidence (e.g. Feder and Onchan, 1987; Matlon, 1994; Hayes, et al, 1997; Roth, et al, 1994; Shiferaw and Holden, 1998) which suggest that the type of investments undertaken and the resultant land productivity in any given farmland as being among other a function of tenure security.[6] Education variable does not significantly influence terracing intensity although the estimated coefficients are negative. This is a surprising result since we expect education to have a significant bearing on resource management on the farm including terraces as an indicator of soil and water management. Possibly the more educated people are, the more likely they will secure off-farm jobs and their managerial inputs on farm level activities may be insignificant.

Social capital elements of membership diversity (*memdive*) and the density of membership in groups (*groups*) significantly shape terracing intensity in Machakos only although they appear to have similar effects when the data are aggregated. Participation does not influence terrace investments. Membership diversity negatively influences terracing intensity. This is an interesting result since it implies that an organization with different characteristics such as age, religion, political affiliation and occupation presents greater opportunities for soil conservation information sharing would be wrong. Possibly greater membership variability is likely to create conflicts or that such people cannot easily mesh up and form one group. As Balland and Platteau (1996) argue, collective action is successful with homogenous groups.

The significant effect of density of membership in groups in terracing especially in Machakos suggest, possibly, the importance of networking since it is evident that as density of membership's increase, the likelihood of deciding to terrace and also the terracing intensity will increase. Furthermore, membership into groups connects one to a variety of people and thereby to a wide information base which may lead to a higher terracing intensity. The other element of social capital such as participation (*particip*) is not significant. This implies that extent of participation in decision making does not influence both the decision to terrace and also terracing intensity.

Extension (*dummyex*) does not have a significant effect on perception although positive as expected with Taita-Taveta and the combined data set. As argued earlier this points to ineffectiveness of the extension service. Yet this is a variable that should condition the diffusion of information about soil erosion problems existing in the area. Alternatively, the aspect of soil erosion does not feature in the extension packages to enable the households to internalize soil erosion problem in relation to sustainable agriculture and agricultural productivity.

The location variable (*district*) is negative and significant. It is therefore evident that Machakos has significantly higher level of soil conservation investments compared to Taita-Taveta. This reflects a greater propensity for Machakos farmers to undertake investments to prevent soil erosion and conserve moisture. This may have to do with learning and copying social dimensions. In Machakos, some of this learning was in the form of an exogenous shock (Tiffen et al. 1994). Terrace construction also started much earlier in Machakos compared to Taita-Taveta, in which case there was enough time for diffusion to spread the technology to other farmers.

Table 5: Tobit regression results on determinants of terracing intensity

Variable	Taita-Taveta (N=33)		Machakos (N=99)		Pooled (N=132)	
	Coefficient	P>|t|	Coefficient	P>|t|	Coefficient	P>|t|
district	-	-	-	-	-0.046(0.286)	0.874
ageh01	0.025(0.020)	0.228	0.006(0.008)	0.483	**0.015(0.008)**	**0.044**
educ	-0.093(0.058)	0.126	0.030(0.033)	0.362	0.034(0.029)	0.246
hhs	0.222(0.138)	0.126	0.058(0.037)	0.114	**0.070(0.038)**	**0.068**
farmca	1.307(0.838)	0.137	**0.439(0.149)**	**0.004**	**0.421(0.155)**	**0.007**
mktacces	**0.011(0.006)**	**0.085**	0.006(0.006)	0.251	-0.001(0.004)	0.858
slope	**-0.787(0.274)**	**0.010**	**0.286(0.123)**	**0.023**	0.099(0.109)	0.365
tenure	0.410(0.300)	0.191	-0.010(0.090)	0.912	0.032(0.092)	0.726
hhincome	**0.000(0.000)**	**0.020**	0.000(0.000)	0.941	0.000(0.000)	0.869
faror	0.367(0.649)	0.579	-0.044(0.300)	0.885	-0.249(0.271)	0.361
perc	0.361(0.760)	0.641	-0.130(0.242)	0.594	-0.223(0.238)	0.351
memdive	-0.202(0.160)	0.223	0.055(0.106)	0.605	**-0.154(0.085)**	**0.073**

[6] In Kenya, though, even squatters can be seen putting soil conservation structures in place in order to strengthen their claim

groups	2.226(1.574)	0.175	-1.133(1.097)	0.305	1.168(0.871)	0.183
particip	-0.083(0.085)	0.342	**0.127(0.071)**	**0.078**	0.041(0.049)	0.412
erode	-0.594(0.745)	0.436	**0.892(0.362)**	**0.016**	**0.634(0.324)**	**0.053**
sex	**-0.742(0.403)**	**0.083**	**-1.234(0.425)**	**0.005**	**-0.664(0.310)**	**0.034**
dummyex	0.701(0.432)	0.123	-0.237(0.265)	0.376	-0.145(0.226)	0.523
Constant	2.514(2.540)	0.336	**4.537(1.080)**	**0.000**	**4.926(1.072)**	**0.000**
Std. Err.	0.859(0.111)	-	0.887(0.064)	-	0.988(0.062)	-
Log likelihood	-41.225		-128.624		-185.611	
Prob>χ^2	0.039		0.015		0.060	

Note: The dependent variable values have been transformed through natural log to reduce dispersion. Figures in parenthesis are standard errors. Bolded coefficient values are significant.

In Table 5 Tobit model estimation results are presented. The estimated model incorporated all the variables that were considered in the Heckman's two-step regression model. However, the perception of the soil erosion problem (*perc*) variable explicitly specified as an independent variable. The dependent variable is terracing intensity (*terrace*). The results show that perception of soil erosion problem does not directly translate into a higher likelihood of increasing investment in soil erosion control through increased terrace intensity or length. Therefore the two-step regression better captures the effect of perception indirectly as a selection variable of samples that exhibit differential terracing.

Conclusions and Policy Implications

The study has established that elements of social capital have a significant role to play in soil conservation in marginal areas. It has also been established that social capital is of various forms and they do not act in the same direction. Three elements of social capital were considered useful in this study namely: density of memberships in a form of the number of groups that a household belongs to, membership diversity in terms the concentration of social groups that are active in the study area, and active participation in decision making within the groups that a household is a member. Generally these components of social capital do not influence the likelihood of acknowledging in terms of raising awareness of the soil erosion problem. These finding is surprising since we did expect that extensive interaction in social groups will add up to information that would influence perception of soil erosion as a problem. Yet it will seem to suggest that policy makers need not worry about diversity of membership nor the participation in decision making by members of groups.

Nevertheless, the number of the number of groups that a household members belong to, the higher the likelihood of a household intensifying investments in terraces in an effort to control the soil erosion problem. Group participation in decision making has no discernable influence on terrace intensity. On the other hand membership diversity influences terrace intensity but negatively. In this scenario, the policy challenge is to come up with innovative and cost-effective measures to encourage household membership into groups. One option is to use the existing groups to remove ceiling on membership and farther encourage people to join. However, in the view that collective action is more successful with smaller groups (Balland and Platteau, 1996), our considered view is to increase the number of groups. This often occurs when non-governmental organizations move in to new areas. Most of these set up committees as part of their community mobilization. With this, new groups are being formed. Another option would be to keep groups that have already been formed active. Besides, once a need that made group be formed in the first place is fulfilled, it is likely that a group may be come inactive. Assisted formulation of new goals or objectives around the same membership such as rotating savings (merry-go-rounds) may help overcome such a pitfall.

The effects of selected socio-economic variables have either global or location specific effects on perception of soil erosion problem and also on terracing intensity. For example education, land tenure security, farm orientation and extension do influence negatively influence perception of soil erosion as a problem in Machakos district. On the other hand the slope of farm fields and the state of erosion do positively and significantly improve perception of soil erosion problem. Age of the household head negatively influences the perception variable whereas field soil erosion status does influence perception positively in Taita-Taveta district. Some of these results are contrary to our expectations and subsequently difficult to account for. We therefore suggest more research into the subject matter. Nevertheless the results that extension has not improved the perception of soil erosion problem raises concern about the packaging of the extension messages or the effectiveness of the extension agency in the advocacy and sensitization programs to farmers on the seriousness of the problem that needs farmers attention.

Terracing, as soil erosion control measure, can and should be handled by individual households who have rights of use of the land resource. Household size, slope, and tenure significantly and positively influence the likelihood of increased terracing in Machakos district. In Taita-Taveta district only age of household head accounts for likelihood of increased terrace intensity while household size, farm capital, and land tenure security are likely to account for reduced terrace intensity. The policy implication is that socio economic factors do matter in soil erosion control efforts. However, since their effect appear to be location specific any policy intervention geared towards increasing terraces on farm fields would apparently vary spatially. Improving land tenure security would significantly improve soil conservation in terms of terracing in Machakos district whereas the converse appears to be true with respect to Taita-Taveta district. The Taita-Taveta results may however not be very reliable considering the sample size of 40. More research may provide additional insights into the effects of these variables in the soil conservation efforts in Taita-Taveta.

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References

Balland, J.M., and Platteau, J.P. 1996. Halting Degradation of Natural Resources. FAO, UN and Clarendon Press, Oxford.

Coleman, J.S. 1988. Social capital in the creation of human capital. *American Journal of Sociology* 94: 95-120.

Cramb, R.A. 2004. Social capital and soil conservation: Evidence from the Philippines. Contributed paper at the 48th Annual Conference of Australian Agricultural and Resource Economics Society, Melbourne, 10-13 February 2004.

De Haan, N., Valdivia, C., Njeru, G. And Sheikh, D. 1996. Of goats, groups, and gender. Kenya SR-CRSP Technical Report Series Paper TR-MU 96-01. University of Missouri, Columbia, Missouri, USA.

Feder, G. and Onchan, T. 1987. Land ownership security and farm investment in Thailand. *Amer. J. Agri. Econ.* 69: 311-20.

Frank, P., Kariuki, G., Wangila, J., Kristjanson, P., Makauki, A., and Ndubi, J. 2002. Assessing the factors underlying differences in group performance: Methodological issues and empirical findings from the highlands of central Kenya. CAPRi Working Paper No. 25.

Granovetter, M. 1985. Economic action and social structure: the problem of embeddedness. *American Journal of Sociology,* 91 (3): 481-510.

Greene, W.H. 2000. Econometric Analysis (Fourth Edition). Prentice-Hall, New Jersey.

Greene, W.H., 1981. Sample selection bias as a specification error: Comment. *Econometrica*, 49: 795 – 798.

Grootaert, C. 2001. Does social capital help the poor? A synthesis of findings from the local level institutions studies in Bolivia, Burkina Faso and Indonesia. World Bank Local Level Institutions Working Paper No. 10. Washington, D.C.: World Bank.

Haddad, L. and Maluccio, J. 2002. Trust, membership in groups, and household welfare: Evidence from Kwazulu-Natal, South Africa. Food and Consumption Discussion Paper No. 135. International Food Policy Research Institute, Washington, D.C.

Hayes, J., Roth, M. and Zepeda, L. 1997. Tenure security, investment and productivity in Gambian agriculture: A generalized probit analysis. *American Journal of Agricultural Economics*, 79(2): 369-382.

Heckman, J. 1979. Sample selection bias as a specification error. *Econometrica*, 47(1): 153-161.

Hill, R.C., Adkins, L.C. and Nender, K.A. 2003. Test statistics and critical values in selectivity models. *In* T.B. Fomby and R.C. Hill (eds), *Advances in Econometrics, Volume 17: Maximum Likelihood Estimation of Misspecified Models: Twenty Years Later*. Elsevier Science: 75-106.

Or: http://www.bus.lsu.edu/academic/economic/faculty/personal/heckit.pdf.

Jaetzold, R., and Schmidt H. 1983. Farm Management Handbook of Kenya: Vol. II Natural Conditions and Farm Management Information, Part C: Eastern and Coast Provinces. Ministry of Agriculture, Nairobi.

Jayne, T.S., Argwings-Kodhek, G. Nyambane, G. and Yamano, T. 1998. Baseline characteristics of smallholder agriculture and non farm activities for selected districts in Kenya. Paper presented at the conference on Strategies for raising smallholder agricultural productivity and welfare, Egerton University/Tegemeo Institute of Agricultural Policy and Development, Nairobi, Kenya, November 24.

Knack, S. and Keefer, P. 1997. Does social capital have economic payoff? A cross-country investigation. *Quarterly Journal of Economics*, 112: 1251-88.

La Ferrara, E. 2002. Self-help groups and income generation in the informal settlements of Nairobi. Working Paper. Bocconi University, Milano, Italy.

Matlon, P. 1994. Indigenous land use systems and investments in soil fertility in Burkina Faso. *In* Bruce J.W. and Migot-Adhola, S.E., (eds.), Searching for Land Tenure Security in Africa. Kendal/Hunt Publishing Company

Narayan, D., and Pritchett, L. 1999. Cents and sociability: Household income and social capital in rural Tanzania. *Economic Development and Cultural Change*, 7(4): 71-93

Obare, G.A., Omamo, S.W., and Williams, J.C. 2003. Smallholder production structure and rural roads in Africa: The case of Nakuru District, Kenya. *Agricultural Economics*, 28(3): 245-254.

Omamo, S.W. 1998. Transport costs and smallholder cropping choices: Application to Siaya District, Kenya. *Amer. J. Agric. Econ*. 80: 116-123.

Putman, D. R. 1995. Comment on The Institutions and Governance of Economic Development and Reform. *In* Bruno M. & Pleskovic B. (Eds.), *Proceedings of the World Bank Annual Conference on Development Economics 1994*, pp 198-200. Washington, D.C., The World Bank.

Republic of Kenya, 1998. First Report of Poverty in Kenya, Volume II: Poverty and Social Indicators. Ministry of Planning and National Development, Nairobi.

Roth, M., Cochrane, J. and Kisamba-Mugerwa, W. 1994. Tenure security, credit use, and farm investment in Rujumbura Pilot Land Registration Scheme, Uganda. In Bruce and Migot-Adholla (eds), Searching for land tenure security in Africa. Kendall/Hunt Publishing Company, Dubuque IA.

Scherr, S.J. 1999. Soil degradation: a threat to developing-country food security by 2020? Food, Agriculture, and the Environment Discussion Paper 27. International Food Policy Research Institute, Washington, D.C.

Shiferaw, S., and Holden, S.T. 1998. Resource degradation and adoption of land conservation technologies by smallholders in the Ethiopian highlands: A study in Andit Tid, North Shewa. *Agricultural Economics*, 18(3): 233-247.

Temple, J. and Johnson, P. 1998. Social capability and economic growth. *Quarterly Journal of Economics*, 113(3): 965-90.

Tiffen, M., Mortimore, M. and Gichuki, F. 1994. More People, Less Erosion. Wiley, Walker, New York.

Uphoff, N., and Wijayaratna, C.M. 2000. Demonstrated benefits from social capital: the productivity of farmer organizations. *World Development*, 28(11): 1975-1890.