Do Tenure Differences Influence the Improvement of Quality of Rented Land? Empirical Evidence from Rural Ghana

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Abstract

The implications of migrant agricultural production for the environment have interested policy makers in sub-Saharan Africa of late. The impacts in the region of migrant destination may be short-term including initial felling of trees, intensive land use, and application of techniques. In the longer term, tenants are expected to adjust their techniques to that of the indigenous landowners. This paper explains how migrant tenants manage the quality of rented plots in the absence of clearly defined property rights with a survey data from rural area in Ghana. An empirical model explaining the probability to invest in land improvements is formulated. The empirical results indicate that tenure differences and income levels of migrants and indigenous landowners play a critical role in investments in land improvements.

1. Introduction

Rural migrant farm households have been perceived as one of the principal agents of environmental degradation in sub-Saharan Africa. This notion has arisen because of the effects of their agricultural activities on the quality of plots which they rent on short-term basis. Due to insecurity of tenure on rented plots, there is the tendency for tenants to use the land continuously in the production of food crops such as maize, yam, cassava, plantain, rice, groundnuts, cowpea and so on. These rented plots are periodically put to fallow by indigenous landowners for the natural vegetation to regenerate and improve the fertility of the soil. The fallowed lands are also enriched with rapidly-growing trees as a means of raising the productivity of forest plots and upgrading the savanna plots.

The impacts of agricultural activities on the region of migrant destination may be two-fold: short-term and long-term. The short-term effects include initial tree felling and application of techniques such as continuous cropping on the same piece of land, mulching, application of fertilizer, and planting leguminous crops as means of soil fertility improvement. In the longer term, tenants are expected to adjust their techniques to that of the indigenous owner-cultivators by planting trees or allowing the plots to fallow. The objective of this paper is to show with a survey data that landless tenants adopt sustainable land use practices on rented plots, although they often lack the incentives to undertake long-term investments on such plots.

The paper then raises two important questions: What short-term and long-term land improvement methods are employed on rented plots? What determines tenant's investments on rented plots? To answer these questions in the rest of the paper, Section 2 examines the environmental improvement discourse in the literature. Section 3 discusses investments on rented plots with a survey data. In Section 4, theoretical model on optimal soil use is formulated. The effects of tenure differences and income on investment in land improvements are quantified with a simultaneous equation model in Section 5. The empirical results are discussed in Section 6. Conclusions are distilled in Section 7.

2. The Discourse on Environmental Improvement

The implications of agricultural activities for the quality of the environment have been controversial in the literature[1]. Hall et al. (1976) have described the transition zone in Ghana as an area experiencing rapid land degradation reminiscent of the savanna of Northern Ghana mainly due to unsustainable land use by man. They argued that the selective removal of trees through felling or burning so as to open the forest canopy and allow sunlight through for cocoa and other food crop production is one of the catalysts for environmental degradation processes in the savanna-forest transition zone. The dominant view is that during land preparation, immigrant farmers slash and burn, cut many trees and stump to make way for construction of mounds and ridges with the view that crops tend to be less productive under shady conditions (Amanor, 1993; Afikorah-Danquah, 1997). The aim of setting these bush fires during land preparation for food crop production is to save time and cash.[2]

Recent studies however appear to have refuted most of the above theories on the transition zone. Current informed studies supported by historical data and ecological

[1] Literature draws a lot from Amanor (1993), Afikorah-Danquah (1997); Leach and Fairhead (2000), and informal discussions with Upper East migrant farm households and owner-cultivated households in Techiman and Nkoranza Districts of Brong Ahafo Region during the farm household survey in 2003.

[2] An informal discussion with an Upper East migrant farmer at Donkro-Nkwanta in Nkoranza District.

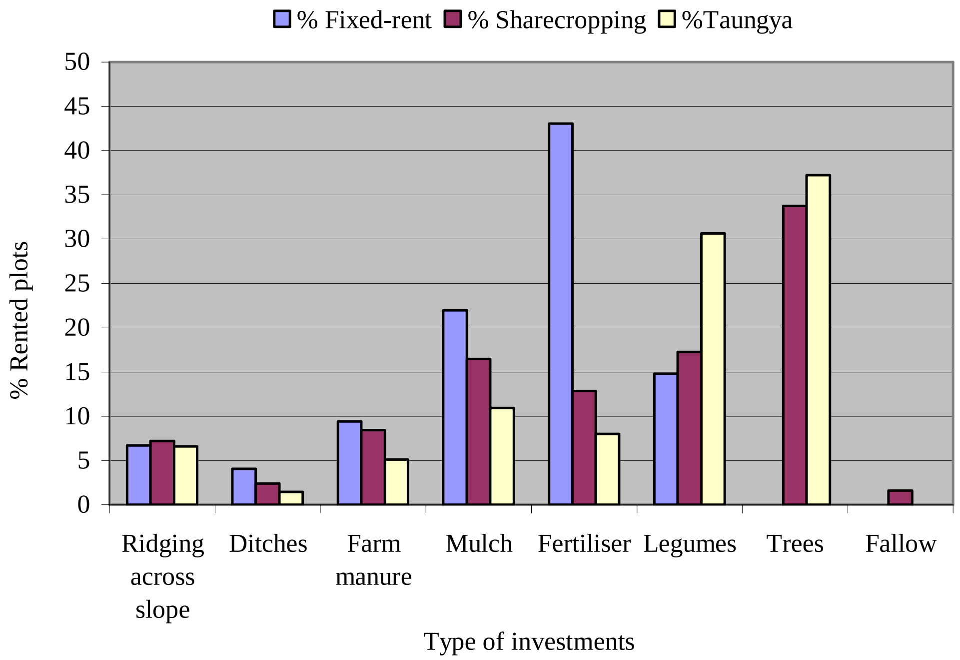
thinking seem to argue otherwise (Amanor, 1993; Afikorah-Danquah, 1997; Leach and Fairhead, 2000). The forest-savanna boundary is believed to have been stable since historical times and have not retreated as earlier works had suggested. Leach and Fairhead (ibid) also show with historical evidence on Ghana and other parts of West Africa that farmers have been encouraging the formation of forest vegetation forms in the savanna through settlement strategies and agricultural practices. Gyasi et al. (1994) note that specific cropping patterns have been adopted to offset the changing conditions in the biophysical environment in the transition zone. Poor farmers also tend to invest more in resource conservation measures when they have available cash from off-farm employment (Clay et al., 1995).

3. Data and Evidence on Investments in Land Improvement Methods

The paper employs cross-sectional data collected in 6 villages from 2 districts in Brong Ahafo Region of Ghana (Owusu 2007). The farm household survey was conducted under the supervision of the author between January and October in 2003. The unit of analysis is the plot-level. A total of 181 samples of Upper East migrant farm households with about 346 rented plots[3] were randomly selected from 4 villages in Techiman District and 2 villages in Nkoranza District of Brong Ahafo Region of Ghana. Similarly, 65 owner-cultivated households with 214 plots were randomly selected from the same locations. The data sets for migrant tenants provide information on their personal history and in-migration, the household's composition, plot-level characteristics, present and future use of plots, household income and assets, non-farm business activities and land improvement methods. With the exception of the history of in-migration, owner-cultivated households were asked similar questions.

[3] The plots rented by Upper East migrant tenants in Brong Ahafo Region of Ghana were the fixed-rent and sharecropping types. Fixed-rent contract is land tenure arrangement in which the landowner hires out or leases part of his land to a tenant for a specific amount and stipulated duration. In sharecropping contracts, the rent is paid from the share of the output produced from the rented land. The tenant pays no explicit fixed cash to the owner but the landowner and the tenant choose between the standardized type of sharecropping contracts known as the *abusa* (one-third of output to the owner) and the *abunu* (a half of the output to the owner). Land acquisition by Upper East migrant farm households in Brong Ahafo Region have been discussed in detail in Owusu (2005).

Owner-cultivated plots were generally more fertile than rented plots of migrant tenants. As indicated in Figure 1, more fertilizer, mulch and farm manure were invested on fixed-rent plots than on sharecropped plots. However no tree planting or fallow was undertaken on fixed-rent plots probably due to lack of incentives to undertake long-term investments on temporarily rented plots. Migrants with taungya plots[4] on the other hand, invested more in trees and legumes.



Source: Author's survey

Figure 1. Investments on rented plots

The short-term land improvements are categorized into cultivation, agronomic and management practices, and erosion control measures (Table 1). The proportion of owners using zero tillage exceeded that of migrant tenants. Zero tillage was not observed among farmers in Nkoranza probably due to wider use of tractor for ploughing and ridging. Minimum tillage involves the use of hoes in the construction of mounds and ridges.

[4] Taungya is a form of land access in Brong Ahafo Region of Ghana where tenants are allowed to farm freely in a designated forest reserve. However, they are required to plant trees under the supervision of the local Forestry Department as means of improving Ghana's forest.

The proportion of owner-cultivators investing in mulch exceeds migrant tenants. Plant residues from previous cultivation are used to prevent the soil from direct impact of rains, sunshine and spread of bush fires. Mulch protects the soil from leaching, and suppresses the regeneration of unwanted weeds. It is mostly practiced by yam cultivators. The most common soil management practices are rotation of crops with legumes and application of fertilizer, and manure. Manuring was more prevalent on migrant plots than owner-cultivated plots. Generally, investments in soil fertility maintenance were higher than soil loss prevention.

Table 1. Distribution of short-term land improvement methods

	% Migrant farm households		% Owner-cultivated households	
Activity	Techiman	Nkoranza	Techiman	Nkoranza
Cultivation Practices				
Zero tillage	13		18	
Minimum tillage	67	64	85	97
Agronomic Practices				
Mulching	41	51	47	83
Management Practices				
Farm manure	23	16	22	7
Legume intercrop	61	78	73	83
Fertilizer application	43	67	69	62
Erosion Control				
Ditches	9	4	18	4
Ridging across slope	65	38	64	41

Source: Author’s survey

The use of fallow for soil fertility enrichments was found only among owner-cultivators. The fallow or rest period allows the natural vegetation to re-emerge to be used as natural fertilizer in the next cultivation period. Fallow periods were between 1-3 years and 4-6 years. Fewer owner-cultivators put plots to fallow for a period of 15 years or more. Fallow was not practiced by tenants because they could not afford to put short-term rented plots to fallow.

The most significant long-term sustainability strategy is tree planting. Some of the predominant trees planted include teak, cashew, oil palm, orange, mango, and indigenous trees. In addition to teak and cashew, some owner-cultivators planted oil palm and mango purposely for income generation. Most indigenous landowners planted trees to secure title to plots but tenants planted trees as part of tenure agreements. In sharp contrast to the high incidence of short-term investments, we observe less investment in trees by tenants. Those who planted trees were located in Aworopata and Woraso in the Techiman District where taungya form of land access is prevalent.

4. Theoretical Model

Following Lopez (1997) and Angelsen (1999), a model of optimal soil use is formulated[5] in this section. Assume a soil capital S at a time t. If depletion rate of the soil capital is $\dot{S}$, the soil capital replenished through land improvement methods by applying labour L is $\phi(L)$ and the amount of soil taken out of agricultural production, A at each time t is δA, then

$$\dot{S} = dS/dt = \phi(L) - \delta A \tag{1}$$

Agricultural production, A is a function of existing soil capital, S and variable inputs, x such as fertiliser, seeds and planting materials.

$$A = f(S, x) \tag{2}$$

Hence from (1) and (2)

$$\dot{S} = \phi(L) - \delta f(S, x) \tag{3}$$

where $\phi_L > 0$, $\phi_{LL} < 0$ and $S(0) = S_0$ and $\delta \neq 0$

The aggregate profit function becomes

$$\Pi = pf(S, x) - wL - \eta x \tag{4}$$

where w is the cost of labour input, η is the price of variable inputs and p denotes the output price.

The relevant optimization problem is stated as

$$Max\ \mathrm{M} = \int_{t=o}^{T} \Pi e^{-rt} dt,$$

subject to $\dot{S} = \phi(L) - \delta f(S, x)$ (5)

[5] The theoretical models by Lopez and Angelsen focused on optimal forest use.

where r is the discount rate.

The optimal control problem can be solved by forming the current value of Hamiltonian

$$H = pf(S,x) - wL - \eta x + \psi(\phi(L) - \delta f(S,x)) \qquad (6)$$

where L and x are the control variables, S is the state variable and ψ is the co-state variable representing the shadow value of soil capital or user cost of soil capital.

The optimal path to steady state equilibrium can be solved by obtaining the first order derivatives

$$\partial H/\partial L = -w + \psi\phi_L = 0 \Rightarrow \ \psi\Phi_L = w \qquad (7)$$

$$\partial H/\partial x = pf_x - \eta - \psi\delta f_x = 0 \Rightarrow (p - \psi\delta) f_x = \eta \qquad (8)$$

$$\partial H/\partial S = \alpha\psi - \dot{\psi} \Rightarrow \ pf_S - \psi\delta f_S = \alpha\psi - \dot{\psi} \ \Rightarrow \ f_S(p - \psi\delta) = \alpha\psi - \dot{\psi} \qquad (9)$$

where α denotes the market interest rate.

$$\partial H/\partial \psi = \dot{S} \Rightarrow \phi(L) - \delta f(S,x) = \dot{S} \qquad (10)$$

Equation (7) implies that in the optimum, the value of marginal product (VMP) of labour used in soil fertility maintenance, $\psi\phi_L$ equals the factor price, w which represents the shadow wage of land improvements. Equation (8) indicates that the VMP of variable inputs equal its price, η. Re-arranging (9), yields $f_S(P/\psi - \delta) + \dot{\psi}/\psi = \alpha$, suggesting that the market interest rate equals the net value of marginal product (rent) of soil capital plus the price per unit of soil capital appreciation or depreciation.

The steady state conditions show the sustainable soil capital use on the land. At the steady state, the soil capital is neither appreciating nor depreciation. So at the steady state

$$\dot{S} = 0 \Rightarrow \ \phi(L) - \delta f(S,x) = 0 \ \Rightarrow \ f(S,x) = \phi(L)/\delta \qquad (11)$$

$$\dot{\psi}/\psi = 0 \Rightarrow \ f_S(P/\psi - \delta) = \alpha \qquad (12)$$

The net VMP is therefore equals to the market rate of return on the other form of capital, α at the steady state. We can solve (7), (8), (11) and (12) to obtain the four unknowns L, x, S and ψ.

5. Empirical Analysis

We investigate in this Section what determines the probability to invest in short-term and long-term land improvement methods. The short-term methods include mulching, crop rotation (with legumes), manuring, application of fertilizer, construction of ditches and ridging across slopes. Although short-term investments in land improvements have short payback periods, they could affect the productivity of the land even in future cropping seasons. The long-term investments include tree planting (owners and tenants) and fallow (owners). The dependent variable is a discrete choice variable in a sense that it measures whether the farmer has invested in any of the land improvement methods on his plot since he acquired (rented) it.

The ability to invest in land improvement methods would depend on the household's heterogeneity in terms of its wealth and human capital endowments. The household's wealth includes livestock and earnings from off-farm employments. Farm characteristics such as acreages under cultivation, previous soil fertility status measured as fallowed years before acquisition of plot and distance of plot from home may influence investment in land improvement method. To control for other tenure arrangements, we include a dummy variable for migrant tenants under the taungya system since they are distinguished by location. The extent to which owners hire out land is controlled with the inclusion of rented-out plots to tenants.

5.1. Model Specification

Assuming that the propensity to invest in land improvement method on a plot *i* by the farm household is a latent variable τ_i^*, we specify the land improvement investment function as

$$\tau_i^* = a_0 + a_1(land)^* + a_2(earnings)^* + a_3(livestock)^* + a_4' z_1 + e_1 \quad (13)$$

where z_1 is a vector of household and plot-level characteristics, and some location dummies; a_1 , a_2 , and a_3 are parameter estimates for land, off-farm earnings and livestock wealth respectively and a_4' is a vector of parameters for household and plot-level characteristics, and location dummies; a_0 is the intercept and e_1 is the error term.

Since τ_i^* is unobserved, we only observe a dummy variable τ_i defined by

$$\tau_i = \begin{cases} 1 \quad if \;\; \tau_i^* > 0 \\ 0, \; otherwise \end{cases} \tag{14}$$

where τ_i =1 if the farmer has invested in the land improvement method on the plot *i* since he acquired the plot and 0 otherwise.

If the error term e_1 in (13) follows a standard normal distribution, then the probability to invest in land improvement method is quantified using a probit model (Maddala 2001). However, acreages under rent contracts, off-farm earnings and livestock wealth cannot be treated as exogenous in the relevant investment equations. Besley (1995) did not take this into account. The endogeneity problem posed by acreages under rent contracts, off-farm earnings and livestock wealth is eliminated by re-specifying the investment equation (13) as a system of simultaneous equations where each of the endogenous variable is expressed in a reduced form comprising of only right-hand side exogenous variables. First, the equation determining acreages under tenancy contracts is expressed as

$$(land)_j^* = b_0 + b_1(earnings)^* + b_2(livestock)^* + b_3' z_2 + e_2 \tag{15}$$

where j =1 if land is cultivated under fixed-rent contract and j =2 if land is cultivated under sharecropping contract; z_2 is a vector of household and farm characteristics and some location dummies; b_1 and b_2 are parameter estimates for off-farm earnings and livestock wealth and b_3' is a vector of parameters for household and farm characteristics and some location dummies; b_0 is the intercept term and e_2 is the error term.

Earnings from off-farm employments and livestock wealth cannot be considered exogenous in (15). So these endogenous variables are further expressed in separate reduced forms (16) and (17) where the right hand side variables are now weakly exogenous (Smith and Blundell, 1986).

$$earnings = c_0 + c_1' z_3 + e_3 \tag{16}$$

$$livestock = d_0 + d_1' z_4 + e_4 \tag{17}$$

where z_3 and z_4 are vectors of exogenous variables explaining off-farm earnings and livestock wealth; c_1' and d_1' are vectors of parameter estimates; c_0 and d_0 are intercept terms; e_3 and e_4 are error terms.

5.2. Estimation Strategy

The land improvement investment equation (13) for migrant tenants is estimated in 3 steps. Firstly, because off-farm earnings and livestock wealth contain a number of zero observations, the reduced form equations (16) and (17) are estimated with a Tobit maximum likelihood. Secondly, the predicted values of off-farm earnings and livestock wealth are substituted into the reduced form equation (15) for the new equation to be estimated with a Tobit maximum likelihood. The Tobit model is appropriate because of zero observations associated with acreages under fixed-rent and sharecropping contracts. Finally, the estimated fixed-rent and sharecropped acreages, together with the estimated off-farm earnings and livestock wealth are substituted into the land improvement investment equation (13) for the final model to be estimated with a probit model. Different probit models are estimated for migrant tenants and owner-cultivators[6]. The treatment of owner-cultivated plots permits the interpretation of the farm size effects on investments. Owner-cultivated acreages are assumed exogenous so the estimation of equation (15) is skipped[7].

The instruments used for off-farm earnings in the land improvement model for rented plots include age, age squared, education and education squared. Livestock wealth was instrumented by age, age squared, education and dummies for religion and veterinary visits. In addition to the estimated land variables, duration of stay, distance of plot from home and previous years of fallow were included in the models. Off-farm earnings of owners were instrumented by age, education and education squared. Livestock wealth of owners was also instrumented by age, education, some demographic characteristics, and dummies for religion and veterinary visits. Off-farm earnings and livestock wealth were measured in Ghanaian Cedis (¢), land cultivated in acres, and age of household head in years. Education

[6] Preliminary investigations showed that tenants and owners have different behavioural functions.

[7] The endogeneity problem posed by land cultivated by owners was ignored in this paper due to data limitations on how owners acquired their plots.

refers to years of formal education of the household head. Age and education proxy for skills and experience of the farmer.

6. Results and Discussions

6.1. Empirical Results

The descriptive statistics of the variables used in the estimation are contained in Table 2. The empirical estimates on the probability to invest in land improvement method on rented

Table 2. Descriptive statistics of variables used in the regressions

	Rented plots (N=346)		Owner-cultivated plots (N=214)	
	Mean	S.d	Mean	S.d
Dependent variables				
Ridging across slope	0.47	0.50	0.28	0.45
Ditches	0.07	0.25	0.10	0.30
Farm manure	0.18	0.39	0.07	0.25
Mulch	0.36	0.48	0.34	0.48
Legumes	0.39	0.49	0.44	0.50
Fertilizer	0.44	0.50	0.39	0.49
Trees	0.51	0.50	0.31	0.46
Fallow			0.74	0.44
Explanatory variables				
Acreage under fixed-rent ♀	1.60	2.47		
Acreage under sharecropping♀	0.79	1.58		
Duration of stay	13.95	9.57		
Land cultivated ♀♀			12.36	17.28
Distance of plot from home	4.40	4.03	0.15	2.11
Previous years of fallow	4.61	5.65	3.36	3.40
Off-farm earnings ♀	2.88	5.41	2.50	6.02
Livestock wealth ♀	15.52	32.21	4.21	54.61
Education	1.93	3.86	6.72	4.91
Taungya dummy	0.15	0.36		
Aworopata dummy	0.09	0.29	0.19	0.39
Woraso dummy	0.21	0.41	0.13	0.33
Ayerede dummy	0.26	0.44	0.28	0.45
Dromankese dummy	0.08	0.26	0.10	0.30

Note: The dependent variable is a dummy variable =1 if investment is undertaken on a plot and 0 otherwise. Land cultivated in acres; fallowed years, education, and duration of stay in years; distance of plots from home in kilometers. Earnings and livestock wealth are in millions of Ghanaian Cedis (¢). Exchange rate: US $1=¢8500 in 2003. ♀Represents variables instrumented in the regression models. ♀♀Refers to land cultivated by owners.
Source: Author's survey.

plots are provided in Table 3. Tenants with large fixed-rent acreages invest less in farm manure but sharecroppers invest more in farm manure. Investment in mulch on sharecropped plots was higher than on fixed-rent plots. Tenants with larger sharecropped

Table 3. Probit estimates of determinants of land improvement participation on rented plots

Variable	Ridging across slope	Ditches	Farm manure	Mulch	Legume	Fertilizer	Trees
Intercept	-0.3145	-2.3779	0.7244	0.9577	-0.3104	0.7696	0.5888
	(-0.62)	(-2.47)†	(1.03)	(1.75)*	(-0.53)	(1.34)	(1.07)
Education	-0.0075	0.0736	-0.1612	0.0106	0.0459	0.0204	0.0188
	(-0.31)	(1.88)*	(3.32)†	(0.44)	(1.83)*	(0.82)	(0.73)
Duration of stay	-0.1061	0.3325	0.2043	0.1267	-0.0349	0.0509	0.0004
	(-2.98)†	(3.59)†	(3.32)†	(3.09)†	(-0.90)	(1.41)	(0.01)
(Duration of stay)^2	0.0022	-0.0084	-0.0057	0.0038	0.0010	-0.0021	0.0004
	(2.23)§	(-2.91)†	(-3.44)†	(-3.30)†	(0.87)	(-2.05)§	(0.34)
Fixed-rent land(est'd)	-0.0653	0.0513	-0.2765	0.0751	-0.2769	0.4941	-0.0379
	(-0.06)	(0.26)	(-1.65)*	(0.62)	(2.09)§	(3.81)†	(-0.32)
Sharecropped land (est'd)	-0.2361	0.5376	1.1059	0.8364	0.1315	0.5396	0.0538
	(-1.10)	(1.34)	(3.31)†	(3.37)†	(0.53)	(2.27)§	(0.23)
Off-farm earnings (est'd)	0.0910	-0.0244	-0.5002	-0.3022	-0.0242	0.0045	0.0607
	(1.28)	(-0.20)	(-4.82)†	(-3.89)†	(-0.32)	(0.06)	(0.79)
Livestock wealth (est'd)	0.0048	-0.0001	0.0157	-0.0229	-0.0139	0.0035	-0.0159
	(0.82)	(0.00)	(1.95)§	(-3.58)†	(-2.13)§	(0.57)	(-2.34)§
Distance	0.0251	-0.0728	-0.0702	0.0369	0.0127	0.0269	-0.0120
	(1.34)	(-1.62)	(-2.13)§	(1.70)*	(0.65)	(1.41)	(-3.63)†
Fallowed years	-0.0048	-0.0514	-0.0056	0.0342	-0.0107	-0.0081	-0.0301
	(-0.33)	(-1.59)	(-0.31)	(2.28)§	(-0.61)	(-0.53)	(-1.48)
Taungya	-0.3675	0.7477	1.4748	0.2913	1.2323	-0.4639	
	(-1.34)	(1.11)	(2.38)§	(0.86)	(4.16)§	(-1.62)	
Aworopata	1.8242	-0.5891	-2.6745	-1.3415	-0.3681	-01505	0.1398
	(4.33)†	(-0.99)	(-4.37)†	(-3.26)†	(-0.90)	(-0.36)	(0.32)
Woraso	0.1121			0.9967	0.4397	0.5078	0.5992
	(0.26)			(1.78)*	(2.88)†	(1.10)	(1.24)
Ayerede	0.1044	0.0768	1.6733	1.2000	-0.0334	1.2418	-0.6862
	(0.34)	(0.12)	(3.42)†	(3.38)†	(-0.09)	(3.82)†	(-1.97)§
Dromankese	0.4046	-0.9895	0.4147	0.0415	0.0848	0.4205	-1.0468
	(1.25)	(-1.49)	(0.84)	(0.12)	(2.35)†	(1.25)	(-2.81)†
Pseudo R^2	0.0895	0.2340	0.2447	0.2155	0.2533	0.1652	0.1620
Log-likelihood ratio	-217.72	-60.44	-111.39	-176.65	-172.45	-198.28	-168.47
No. of observations	346	273	273	346	346	346	295

Note: † significant at 1%, § significant at 5%, * significant at 10%.
Source: Author's survey

acreages invest more in fertilizer than those with fixed-rent acreages probably to secure longer tenure duration. Due to tenure insecurity on rented plots, we expect long-term investments on fixed-rent and sharecropping plots to be lower, *ceteris paribus*. Empirically, investment in trees was insignificant even at 10 percent on rented plots.

Table 4. Probit estimates of determinants of land improvements on owner-cultivated plots

Variable	Ridging across slope	Ditches	Farm manure	Mulch	Legume	Fertilizer	Trees	Fallow
Intercept	-0.9320	0.5562	0.6577	0.0292	-0.9477	-0.3811	-0.8431	0.4346
	(-2.05)§	(0.86)	(0.60)	(0.06)	(-2.11)§	(-0.85)	(-1.77)*	(0.73)
Education	-0.0042	-0.1433	-0.0832	-0.0062	0.0251	0.0045	-0.0601	0.0253
	(-0.15)	(-2.78)†	(-1.19)	(-0.23)	(0.98)	(0.17)	(-2.09)§	(0.74)
Land	0.0066	0.0034	-0.2751	-0.0131	0.0062	0.0132	0.0043	0.0403
	(1.12)	(0.39)	(-2.76)†	(-1.98)§	(1.10)	(2.19)§	(0.75)	(2.36)§
Off-farm	0.0620	-0.1312	-0.3748	-0.0657	0.0243	0.0227	-0.1149	0.0508
earnings(est’d)	(1.55)	(-1.71)*	(-2.53)†	(-1.66)*	(0.65)	(0.60)	(-2.51)†	(0.94)
Livestock wealth	0.0597	-0.1036	-0.0507	-0.0796	0.1266	0.0386	0.0334	0.0827
(est’d)	(1.21)	(-1.44)	(-0.51)	(-1.72)*	(2.72)†	(0.84)	(0.67)	(1.37)
Distance	-0.0027	-0.0173	0.0629	-0.0255	-0.0412	-0.0137	0.0126	-0.0715
	(-0.05)	(-0.41)	(0.99)	(-0.77)	(-1.41)	(-0.47)	(0.40)	(-1.90)*
Fallowed years	0.0066	-0.0052	-0.0821	0.0157	0.0132	-0.0197	-0.0189	0.3751
	(0.29)	(-0.11)	(-0.92)	(0.57)	(0.47)	(-0.71)	(-0.65)	(6.45)†
Rented-out plot	-0.1398	-0.1364	-0.1788	-0.0408	-0.1178	-0.2175	-0.0179	-0.1948
	(-0.95)	(-0.67)	(-0.68)	(-0.29)	(-0.86)	(-1.57)	(-0.12)	(-1.07)
Aworopata	0.7412	-0.3898	-1.2064	-0.0396	0.4008	0.4557	0.7279	-1.2425
	(2.33)§	(-1.00)	(-2.19)§	(-0.14)	(1.36)	(1.56)	(2.36)§	(-3.04)†
Woraso	0.6612	-0.1114		-0.6041	0.6918	0.2489	0.1471	-0.7634
	(2.04)	(-0.26)		(-1.54)	(2.25)§	(0.81)	(0.42)	(-1.95)*
Ayerede	0.5286	-1.2219		0.6366	0.7048	0.5546	0.4252	-1.4115
	(1.77)*	(-2.70)		(2.35)§	(2.56)†	(2.00)§	(1.44)	(-3.59)†
Dromankese	-0.7199		0.6078	-0.2818	0.7881	-0.2561	1.480	
	(-1.28)		(0.79)	(-0.69)	(2.03)§	(-0.63)	(3.45)†	
Pseudo R^2	0.1063	0.1194	0.3010	0.1126	0.0159	0.0755	0.1238	0.4340
Log-likelihood ratio	-112.61	-58.47	-30.8856	-121.88	-135.32	-132.53	-116.55	-65.79
No. of observations	214	193	128	214	214	214	214	193

Note: † significant at 1%, § significant at 5%, * significant at 10%.
Source: Author’s survey

Tenants with higher off-farm earnings invest less in farm manure and mulch. Those higher livestock wealth invest more in manure but decrease investments in mulch and legumes. Apart from tree planting, tenants with taungya plots also invest more in farm manure and legumes. The effects of the size of farm on investment in farm manure or fertilizer if extra unit of fixed-rent and sharecropped acreages are added are 0.8294 and 1.0337 respectively[8]. When a unit of fixed-rent acreage is replaced by a unit of sharecropped acreage, the effect of tenure composition on investment in farm manure or fertilizer are -1.3824 and -0.0455 respectively.

We turn our attention on the empirical estimates of investments by owner-cultivators. The descriptive statistics have been provided in Table 2 and the estimation results are reported in Table 4. Owner-cultivators with larger acreages invest more in fertilizer and fallow but less in farm manure and mulch. The extent to which owners hire out land to tenants do not influence investments on their plots. Similar to what occurred on rented plots, owners with higher off-farm earnings do not invest much in ditches or farm manure or mulch or even trees as soil quality improvement. Owners with higher livestock wealth invest more in legumes but less in mulch.

7. Summary and Conclusions

This paper has analyzed the effects of tenure differences on the quality of soil in a rural area of Ghana. Despite lack of incentives to undertake long-term investments on rented plots, landless tenants resorted to short-term investments. The effects of tenure differences and income levels on the propensity to undertake short-term or long-term investments were empirically tested. The results were robust as the endogeneity of off-farm earnings, livestock wealth and acreages under tenancy contracts were accounted for. The results revealed that tenants with larger sharecropped acreages invest more in mulch and farm manure but those with larger fixed-rent acreages invest less in mulch and farm manure.

The prospects for tenants include long-term tenure arrangements where trees for instance, could be sharecropped. The possibility of re-entering into new contract terms would ensure continuity of cultivating crops and applying techniques that improve the

[8] The sum (or average) of the coefficients of the two land variables simulates what would happen if an extra unit of both types are added (i.e. the effects of farm size). The difference simulates what would happen if a unit of sharecropped land is replaced by a unit of fixed-rent land (i.e. effects of tenure composition).

quality of soil on rented plots and relative income positions of tenants. Enhancing farmers' efficiency and skills through effective extension delivery is one of the policy options that could maintain fertility of rented plots. Replicating profitable agro forestry systems will go a long way to reduce rural poverty and improve the forest vegetation. Also the development of improved species, especially rapidly growing commercial trees must be pursued. The crusade against wild and bush fires should be stepped up by stakeholders involved in environmental conservation.

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