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An analysis of household farm investment decisions under varying land tenure arrangements in Ghana

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Abstract

Land tenure insecurity is widely perceived as a disincentive for long-term land improvement investment hence the objective of this paper is to evaluate how tenure (in)security associated with different land use arrangements in Ghana influenced households' plot level investment decisions and choices. The paper uses data from the Farmer-Based Organisations (FBO) survey. The FBO survey collected information from 2,928 households across three ecological zones of Ghana using multi-staged cluster sampling. Probit and Tobit models tested the effects of land tenancy and ownership arrangements on households' investment behaviour while controlling other factors. It was found that marginal farm size was inversely related to tenure insecurity while tenure insecurity correlate positively with value of farm land and not farm size. Individual ownership and documentation of land significantly reduced the probability of households losing uncultivated lands. Individual land ownership increased both the probability of investing and level of investments made in land improvement and irrigation probably due to increasing importance households place on land ownership. Two possible explanations for this finding are: First, that land markets and land relations have changed significantly over the last two decades with increasing money transaction and fixed agreements propelled by population growth and increasing value of land. Secondly, inclusion of irrigation investment as a long term investment in land raises the value of household investment and the time period required to reap the returns on the investments. Households take land ownership and duration of tenancy into consideration if the resource implications of land investments are relatively huge and the time dimension for harvesting returns to investments is relatively long.

Keywords: Ghana, Land tenure, soil improvement, investment decision, probit

1 Introduction

Tenure security enables farmers make long-term investments to improve soils in the expectation that they will hold their land rights long enough to reap the associated benefits. Secure land rights provide incentives for investing in soil conservation, land improvements and other productivity-enhancing operations since farmers are assured of reaping the stream of benefits associated with their investments (Platteau, 1995). In contrast, the effect of lack of land tenure security is uncertainty in a farmer's mind about the value of improvements made to the land. This uncertainty tends to increase as farming becomes more commercialised and expected to have a bearing on how farmers manage their land and thus influence agricultural productivity (Alemu, 1999; Sjaastad & Bromley, 1997).

Low agricultural investment and productivity in Ghana have among other things, been attributed to problems with security of land rights and gender disparity with respect to access to and control of productive resources including land (Agbosu, 2000; Tsikata, 2003).

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With public agricultural investment at nine percent of GDP, and trailing the Comprehensive African Agricultural Development Program (CAADP) - Maputo Declaration's target of 10 percent, it is worrying that Ghana's quest to modernise agriculture and maintain growth levels consistent with middle income economies would be severely compromised if the levels of private and public investments in agriculture remain low. Though a multiplicity of factors may account for the low agricultural investment in Ghana, the land tenure and administration system has often been cited as a disincentive for land investment. Aryeetey & Udry (2009) reports that land and its management in Ghana has often been poorly understood and is generally perceived to induce tenure insecurity.

Land tenure and administration system in Ghana is a combination of customary and statutory processes. Customary land tenure systems are usually managed by traditional rulers, land earth priests, council of elders, and family or lineage heads. Legislations and interventions by colonial and early post-independence governments led to the establishment of the pluralist legal system in which English common law was grafted onto Ghanaian communal societies, largely neglecting differences between the early 19th century capitalist economic structures and the egalitarian communal institutions of Ghana (Agbosu *et al.*, 2007). The resulting legal pluralistic land administration has laid the foundations for conflicts and is widely perceived to induce tenure insecurity which has hindered farm investments and agricultural growth (Agbosu *et al.*, 2007).

This paper examines smallholder farmers' land investment decisions under varying land tenure arrangements using plot level data from 2,928 households across Ghana. The paper is motivated by the increasing need for knowledge on how indigenous land tenure arrangements influence the willingness of plot holders to undertake long-term soil and farm improvement investments. Exploring how land relations in Ghana affect farm households' investment behaviour supports the achievement of the dual goals of identifying entry points for government to influence smallholder farm investment and also providing feedback for ongoing land tenure and administration reform.

2 Land tenure and smallholder farm investment: the theory and empirical evidence

Resource allocation under different land use arrangements has been a subject of debate in theory especially on the subject of enforceability of land and labour contracts (Otsuka *et al.*, 1992). Marshall (1890) and Mill (1848) conclude that share tenancy results in inefficient resource allocation, arguing that since the share tenant receives as marginal revenue only a fraction of the value of his/her marginal product of labour, the tenant's incentive to supply labour or other inputs at the optimum level is limited[1]. On the other hand, Cheung (1969) and Johnson (1950) have contended that, if effort is costlessly enforceable, sharecropping arrangements can be as efficient as owner-cultivated and fixed-rent tenancy. Ahmed *et al.* (2002) reports that relative to land cultivated by owners and fixed-fee rental land, alternative land tenure systems such as sharecropped and gifted land prevailing in Ethiopia were less efficiently cultivated and resulted in considerable economic losses to farmers due to the restrictions imposed by landowners on the latter. They suggested that policies that facilitate individualised land transactions would result in considerable gains to farmers in particular and the national economy at large.

The growing list of studies examining the relationship between land tenure security and long-term farm investment or productivity have done little to quell uncertainty and controversy over the much hypothesised nexus especially in Africa. Most of the studies in Africa, including those mentioned above have produced mixed results with the greater majority failing to establish the hypothesised strong links between tenure security, investments and productive efficiency.

Considering the relationship between land title and investment, most empirical studies have produced inconclusive results. In Ghana, Rwanda and Kenya for example, Migot-Adholla *et al.* (1991) found that increasingly individualised land rights do not appear to have any effect on agricultural investment and yields. In areas of Kenya with land registration, no link was found between land titling and long-term investments to improve land (Barrows & Roth, 1989). In Zimbabwe, Harrison (1987) found little variation in the productive performance between small holder farmers with no land title and large scale commercial farmers with land titles.

Evidence linking individualised land rights with higher productive efficiency is weak and inconsistent. Though Laffont & Matoussi (1995) found significant evidence of inefficiency under sharecrop arrangements in a study in Tunisia, the study failed to provide evidence

[1] The tenant receives a predetermined share of the output (e.g. 40 %) and also pays or decides on variable input use. The exogenously determined share of the output may under value his labour and variable input contribution or over compensate the landlord for use of the land.

of higher efficiency under individualised land holdings. Ahmed *et al.* (2002) found significant inefficiency on sharecropped land but not so on land under fixed-rent contracts. Unlike in Africa, the evidence on the relationship between titled land rights and productivity has been more consistent in Asia and Latin America, where some link is established between yields, farm investments and tenure security Feder *et al.* (1987); Salas *et al.* (1970); Shaban (1987); Villamizar (1984).

A cursory look at the approaches used in investigating the tenure security-productivity hypotheses in Ghana reveals a certain degree of proclivity to notions of superiority of individualised land rights and land titling as ultimate determinants of tenure security. As a result, the research into the land tenure security-productivity hypotheses appears lopsided with emphasis on identifying analytical and modelling deficiencies as opposed to interrogating issues that border on conceptualisation and operationalisation of land tenure security, the most significant parameter of the hypothesis.

The common response to the failure to observe expected relationships between tenure security and productivity is the attempt to argue that tenure security is endogenous and that earlier studies lacked the econometric rigour to adequately account for the perceived endogeneity of tenure security (Besley, 1995; Hayes *et al.*, 1997; Twerefou *et al.*, 2011). Many of the more recent investigations of the tenure security-productivity hypotheses have therefore focused on resolving the issues of endogeneity in tenure security mostly through multi-stage econometric modelling (Besley, 1995; Hayes *et al.*, 1997; Twerefou *et al.*, 2011). The findings of these studies however have not been radically different in terms of resolution of the ambiguity surrounding the relationship between tenure security and expected improvements in investments.

Using the same data set as Migot-Adholla *et al.* (1991), Besley (1995) assumed that land rights were endogenous with farmer investment aimed at improving their rights over land. He concluded that better land rights facilitated investment in Wassa but not in Anloga, a direct opposite of the findings made by Migot-Adholla *et al.* (1991). Twerefou *et al.* (2011) in their study of tenure security, investments and the environment in Ghana, set tenure security as endogenous. They found that investments in farmlands in Ghana were low, appeared not to enhance tenure security, and argued that the reverse causation assumption of tenure security enhancing investment seemed non-existent. They further concluded that tenure security appeared to be an incentive for investment and had a positive and significant effect on investment though the authors suggested the results were not robust because the model did not control for endogeneity. Twerefou *et al.* (2011) are contradicted by Dzanku (2007) who failed to establish an overwhelming link between land rights and investment in irrigation and soil improvements.

The farmer bases his investment decisions on his level of tenure security and chooses between investments in capital equipment, which is not lost in the event that he/she loses his rights to land and long-term soil improvement and irrigation-related investments, which are completely lost in an eviction (Feder *et al.*, 1987). Several studies on land tenure security and farm investment and productivity, including Place & Hazell (1993) in Ghana, Rwanda and Kenya, and Hayes *et al.* (1997) in Gambia have applied the Feder *et al.* (1987) framework.

The model assumes that the household's utility is increasing in present value of future income stream (π), and household characteristics and asset wealth (H^c):

$$
\begin{aligned}
& max_{I_i} U[E(\pi_t); H_t^c] \quad \text{Subject to} \\
& \qquad E(\pi_t) = \sum_{t=1}^{T} \delta^t (p_t q_t A_t E[\omega_t] - cI_i(\epsilon_e) I_{it}; H_t^c) \\
& q_t = y(s_t, K_t) \\
& s_t = s_0 \left(1 - er(\varphi^t, \sum_{\omega=1}^{t} I_{i\omega})\right) \qquad (1)
\end{aligned}
$$

Where π_t the value of future income stream (π_t) at the end of the household's planning (T), cI_i is the unit cost of conservation investment (I_i) discounted by δ^t. H_t^c denotes household asset wealth characteristics. The unit cost of conservation investment is assumed to be decreasing in level of farmer experience ($cI_i(\epsilon_e) < 0$). The expected crop revenues are given by the product of crop price (p_t) and yield (q_t), and land area (A_t), and dichotomous expectation of land tenure in the period $t(E[\omega_t])$. Yield in season t is assumed to be concavely increasing with soil depth[2] ($q'(s_t) > 0$) and also a function of other conditioning factors (K_t) such as weather, pests and soil fertility.

Unlike Place & Hazell (1993) and Hayes *et al.* (1997), this study adds the dimension of investment in the development of irrigation structures.

[2] Soil depth is a proxy of good soil conditions. Deep and friable soil is presumed good conditions for crop productivity and yields are assumed to increase with improving conditions. Soil depth is defined as depth in soil to which the roots of a plant can readily penetrate.

3 Methodology

3.1 Empirical model

Based on the theory and the large body of empirical research undertaken on the subject of land tenure and farm investment across a number of African countries by Clay *et al.* (1998), Feder & Feeny (1993) and Hagos & Holden (2006) the study sets the household as a utility maximizing entity that chooses between short-term complementary inputs use and long-term land investments based on the household's rate of time preference and specifies an estimable empirical model as:

$$I_i = f(tenure, wealth_{t-1}, H^c_{T-1}, plot, market, crop, Zone) \quad (2)$$

where: I_i measures household conservation and irrigation investment in plot *i*. The survey solicited household responses on the investments made in soil and water conservation and irrigation expressed in Ghana Cedi (GHS). The tenure variable represents factors that influence the farmer's expectation of retaining tenure or land rights such as whether the plot is owner operated, rented, temporally transferred (loaned). The duration of tenure is also included and is expected to improve farmers perceived tenure security. The $wealth_{T-1}$ variable denotes household wealth and asset holdings including relative farm size, livestock holdings, labour and other resource endowments. H^c_{T-1} represents household demographic characteristics such as age and education of household head. The variable *plot* represent farm characteristics such as soil type, drainage, degree of fragmentation (ratio of total number of parcels to total farm size), and access to irrigation. The variable *market* measures market access variables such as borrowing and access to agricultural extension information. The variable *crop*[3] denotes the type of crop cultivated, either short duration crops or annuals or perennials that require land for several seasons. The *zone* variable controls for location fixed effects such as distance to markets, population density and rainfall.

The household soil conservation and irrigation investment decision making is assumed to happen at two levels. The household first decides whether to invest or not to invest and upon deciding to do the former, make decision on the level of investment. Both decisions are influenced by factors including those outlined in the empirical model (equation 3.). The level of conservation is given by

$$I^L = X_1\beta_1 + \varepsilon_1 \quad (3)$$

where I^L is the level of household conservation investment which depends on the vector of X_1 explanatory variables outlined in (2).

The decision to invest or not is given by

$$I^D = X_2\Omega_2 + \nu_2 \quad (4)$$

where (X and I^D) are observed, whereas I^L is observed only when $I^D = 1$.

The model assumes that $\varepsilon_1$andν_2 are independent of X implying that X is exogenous, and $\nu_2 \sim N(0, 1)$. Given such a model, if the error terms in Equations (3) and (4) are related, they must first be estimated jointly given the premise that the household chooses whether to invest and then, having decided positively chooses the level of conservation investment. This implies there could be problems of selection bias hence requiring that the two equations be estimated jointly. The estimation procedure therefore involved testing for the presence of selection bias using the Heckman selection model (Heckman, 1990), and examining the likelihood ratio test of independence.

Sample selection bias was tested using a Heckman two-step model (Deaton, 1997). Adjustment for the standard errors in the level of investment model (equation 3) for heteroscedasticity using Powell's Censored Least Absolute Deviations (CLAD) estimator was done. The CLAD estimator unlike the standard estimators of the censored regression model is robust to heteroscedasticity, consistent and asymptotically normal for a wide class of error distributions (Arabmazar & Schmidt, 1981).

The Heckman test for sample selection bias tests the null hypothesis of H_0: $\rho\varepsilon_1\nu_2 = 0$ and the alternative hypothesis H_A: $\rho\varepsilon_1\nu_2 \neq 0$. The measure of correlation between ε_1 and ν_2 is the correlation coefficient ρ. If the study rejects the null hypothesis of $\rho\varepsilon_1\nu_2 = 0$, then the decision to invest equation (the sample selection equation) and the level of investment (outcome equation) cannot be said to be independent and thus must be estimated jointly by the Heckman technique. The Wald's test of independence indicates that $\rho\varepsilon_1\nu_2$ is not significantly different from zero hence failure to reject the null hypothesis H_0: $\rho\varepsilon_1\nu_2 = 0$ i.e. the models revealed no significant selection bias. As indicated, the significance of this result is that the sample selection (decision to invest) and outcome equations (money value of investments) could be treated as two independent equations and estimated separately.

[3] Dummies for annual crops (including maize, millet, cassava, cowpea, yams, among others); perennial cash crops (comprising cocoa, oil palm and mango); non-perennial cash crops (pineapple, soybean, melons)

The binomial probit and censored regression (Tobit) models were used to estimate the decision to invest and level of conservation and irrigation investments, respectively. When the dependent variable is dichotomous (0, 1), the probit and the logit models are preferable but for continuous dependent variables that are censored at or below zero the Tobit model is preferable (Anley *et al.*, 2007). The Tobit model is used to allow for censoring of households that made zero investment in land improvement.

The standard Probit and Tobit models may be formulated as:

$$y_i^* = x_i'\beta + \epsilon_i$$
$$y_i = \begin{cases} 1 & \text{if } y_i^* = 1 \\ 0 & \text{otherwise} \end{cases}$$

$$y_i^* = x_i'\beta + \epsilon_i$$
$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0 \\ 0 & \text{if } y_i^* \leq 0 \end{cases} \quad (5)$$

where $i = 1, 2, \ldots, N$, and ϵ_i is assumed to be NID $(0, \delta^2)$ and independent of x_i. This model is a censored regression model where observations may be censored from below.

3.2 Study area and data

The study used the Farmer Based Organisation (FBO) survey data collected by the Institute of Statistical, Social and Economic Research (ISSER) of the University of Ghana in 2008 (ISSER, 2008). The survey was intended to facilitate the monitoring and evaluation of the Millennium Challenge Compact signed between the Government of Ghana and the Millennium Challenge Corporation (MCC) of the United States of America.

The strength of the data used for this study lies in the geographical spread of the sample. Land tenure systems in Ghana have been largely influenced by ethnicity, population pressures and agriculture intensification, with the land tenure systems in the South differing from tenure systems prevalent in the Northern parts of Ghana. Geographically, the study covered six regions; Northern, Central, Eastern, Volta, Ashanti and the Greater Accra Regions located in three ecological zones.

A sample of 2,928 farm households drawn from 23 districts in six regions within the three distinct agro-ecological zones of Ghana, namely, the Northern Agriculture Zone (Northern Region of Ghana), the Afram Basin (Ashanti and Eastern Regions of Ghana), and the Southern Horticultural Belt (South-East Coastal Plains of Volta Region) was used (Figure 1).

The FBO survey collected information on the overall living circumstances and farming activities of members of FBOs and their respective households. In-depth household data was collected using two sets of questionnaires; a household questionnaire and a community questionnaire: The survey collected information on a wide range of household attributes including the demographic, education and health characteristics; migration; household transfers; information seeking behaviour of households; household assets and participation in financial markets (borrowing, savings and lending behaviour); household agriculture activities including land ownership and transactions and agriculture processing and, non-farm enterprises of households. Information was also collected on the location of households, community facilities and farm sizes using geographic position system units (GPS). The community questionnaire was essentially a market price survey.

The data was collected using multi-stage probability sampling, clustered, and stratified with probability proportional to the size of target population to sample households. The approach used a two-stage sampling technique. During the first stage, 27 enumeration areas (EAs) were selected using systematic sampling with probability proportional to size method (PPS) for each district. The EAs were the same as those used during the 2000 Population and Housing Census by the Ghana Statistical Service (GSS, 2000). The selected enumeration areas were listed fully to know the total number of households that served as sampling frame from which an appropriate sample size was selected.

4 Results

4.1 Descriptive statistics

Table 1 presents description and summary statistics of variables used in equations 3 & 4.

The standard errors were adjusted to correct for clustering effects. Only 20 % of sampled households are female-headed. Although about 70 % of household heads reported to have attended basic school, only about 20 % are able to read and write a simple sentence in English.

Only 14 % of sampled households perceive their tenure status as insecure. The distribution appears to be even across observations in terms of the modes of land acquisition and forms of land rights. Though 30 % of sampled households have land titles, only 20 % are reported to exercise complete rights over their land. Close to 20 % of households purchased their land outright while 30 % received land as gifts. Only one percent

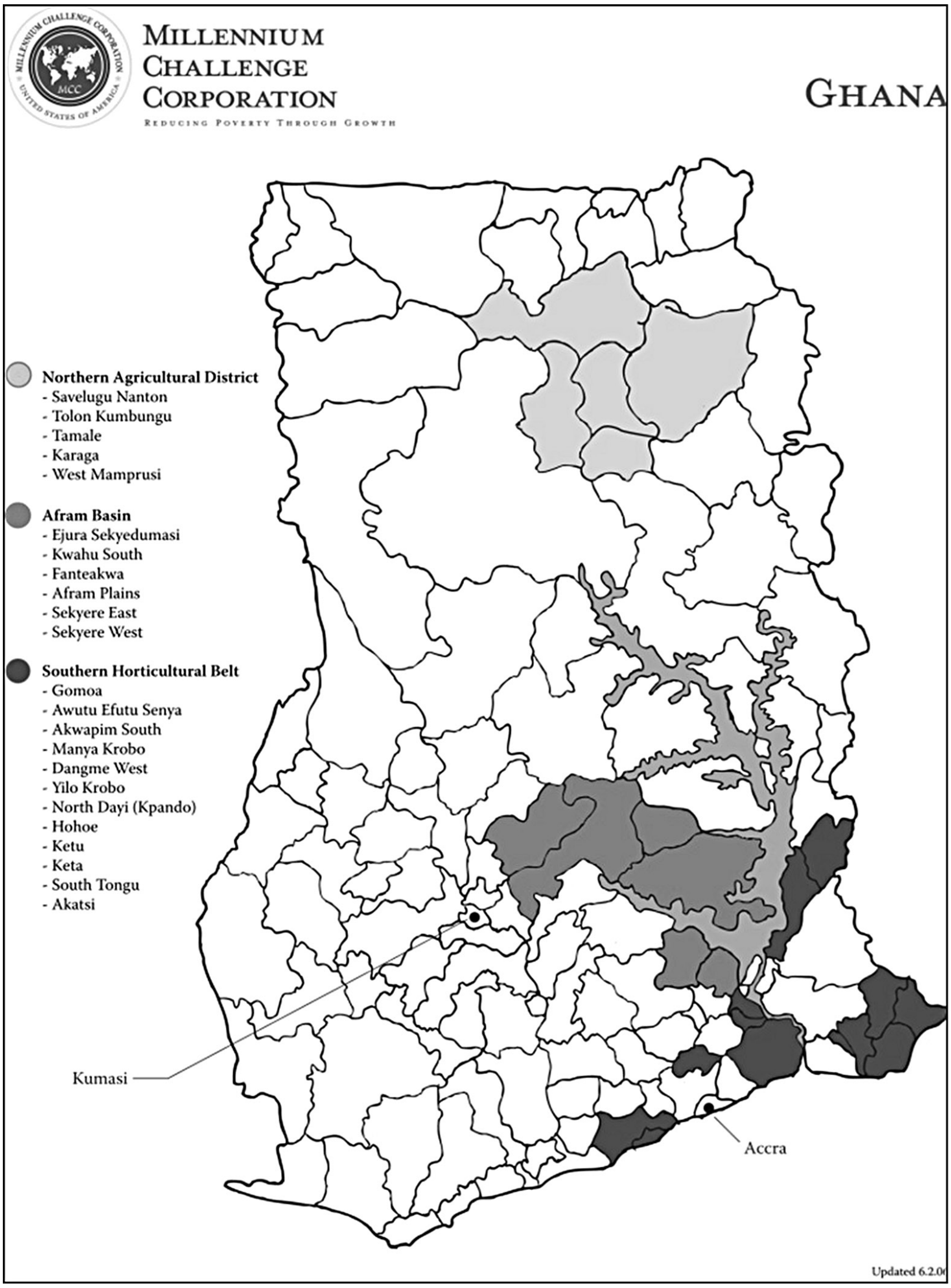

Fig. 1: *The study area in regions and districts*

of land is held in sharecropping arrangements. About 80 % of sampled households indicated they could vacate their lands and still maintain ownership but the period of time for which they could vacate the plots averaged at 6 months of the production season.

About a third of sampled households made land improvements and irrigation related investments. Households invested an average of about GHS 200[4] per acre on land improvement and irrigation. Compared with average value of farm produce and average non-farm income, households invest about 29 % of farm revenue (excluding livestock) or 60 % of non-farm revenue. Sampled households have owned and used land for over 9 years on the average with over 10 % of the farms enclosing pre-existing physical structures such as farm houses, fences, and storage yards among others.

[4] GHS 200 is equivalent to USD 95 at the then prevailing exchange rate of 2.1 Ghana Cedis (GHS)

Table 1: *Descriptive statistics*

Variable and Description	*Estimate*	*Standard Error*
Household Characteristics		
Sex (dummy 1= male 0= female)	0.8	–
Age (Number of years)	47.1	12.7
Dependency ratio (ages below 15 and above 64/ ages 15 to 64)	1.1	0.9
Basic education (Dummy 1=attended basic school 0=otherwise)	0.7	–
Literacy (dummy, 1= can read and write; 0=otherwise)	0.2	–
Assets and Wealth variables		
Livestock Holding (in Tropical Livestock Units)	2.5	7.9
Land Holding (acre)	12.2	11.7
Value of output (GHS value of output per acre)	695.1	3,888.7
Family labour (man hours per season)	270.8	573.5
Non-farm income per household (GHS)	336.5	2,001.1
Land Tenure and Security Variables		
Ownership with deed (Dummy, 1= registered land with deed; 0= otherwise)	0.3	–
Gift land (Dummy, 1= received land as gift; 0= otherwise)	0.3	–
Sharecropped land (Dummy, 1= land acquired under sharecropping; 0= otherwise)	0.1	–
Assurance of tenure security (number of years)	0.5	0.7
Years of land ownership (Number of years)	9.1	6.7
Probability of investment in land (1= if household made investment and 0= otherwise)	0.3	–
Intensity of investment land (in GHS)	202.5	846.7
Number of physical structures (farm houses, storage houses)	0.1	0.5
Crop and Location Variables		
South (Dummy, 1= southern horticultural belt; 0= otherwise)	0.2	–
Northern agricultural zone (Dummy, 1= northern agricultural zone; 0 =otherwise)	0.4	–
Affram Basin (Dummy, 1= Affram Basin; Otherwise=0)	0.3	–
Cash crops (Dummy, 1= cash crops; 0 = otherwise)	0.1	–
Plot Characteristics		
Index of land fragmentation (Number of plots/ acre)	1.6	1.8
Access to irrigation (Dummy, 1= irrigated, 0= land rain-fed)	0.1	0.3
Soil water retention (Number of hours it takes farms to drain)	21.4	70.1
Ratio of zonal to household farm [5]	0.9	0.0
Market Access and Participation		
Receive extension visits (1= farm received extension visit 0=otherwise)	0.5	
Distance to major market (Kilometers)	2.3	16.5
Adoption of technologies (Dummy, 1= yes; 0= no)	0.2	

Source: Authors' computations from *MIDA FBO Survey, 2008*

[5] Refers to the farm size per capita of the household divided by the average farm size per capita in the zone.

Larger dispersions occur in farm revenue, non-farm income and household labour use. Since farm sizes and scales of production vary it is expected that larger dispersions would occur in farm revenue. Larger families tend to have more access to family labour. The large standard deviation of family labour use is in tandem with the wide variation in family sizes.

The result of the probit model of the decision to invest in soil and water conservation and irrigation is presented in Table 2. Endogenous variable such as the number of physical structures established on the land by the household were excluded from the model because of lack of appropriate instruments that would enable us to predict the variable.

Land tenancy arrangements such as renting and sharecropping were found to have significant influence on households' decision to invest and had the expected negative signs. While land ownership (without deed) did not exert a significant influence on the probability of households deciding to invest, land documentation (ownership with deed) was found to exert a positive effect on the decision to invest and was significant at the 10 percent level. Households were also found to be less willing to invest in farm lands they received as gifts (gifted land) and which they had not formally documented as well as on sharecropped plots. The assurance of tenure security exerted a significant and positive effect on the probability of investing in soil and water conservation and irrigation.

The distance to major markets was found to exert a negative effect on the decision to invest and was significant at 1 %. Access to irrigation as well as the ratio of household to zonal land size also had the expected significant positive effects on the decision of households to invest.

The effect of household resource endowment on the decision to invest was found to be mixed. Household livestock expressed in Tropical Livestock Units (TLU)[6] had no significant influence on this decision. On the contrary, labour availability (family labour) and value of output per area (or crop income) did significantly increase the probability of households deciding to invest in land conservation and irrigation. Households with high labour would be in the position to implement complementary farm activities required to optimize the benefits from land improvement related investment.

Location of households and crop characteristics such as cultivation of cash crops were also found to have significant effects on the decision to invest. Compared with the southern horticultural belt (used as the reference category), households located in the Affram Basin and the northern agricultural zone had higher propensities to invest contrary to *a priori* expectations that the relatively high level of commercialisation of agricultural products and the higher population density in the South would make these households more willing to invest in land improvements.

Cultivation of vegetables and spices was found to positively influence the decision to invest in soil and water conservation and irrigation. This was expected since the production of vegetables and spices in many instances is done in the dry or minor seasons and would usually involve significant investment in irrigation. The cultivation of perennial cash crops and non-perennial cash crops had the expected positive and negative coefficient signs, respectively, but only the coefficient for non-perennial cash crops was statistically significant.

Land fragmentation[7] had a positive effect on the probability of investing and was significant at 1 %. The ratio of zonal to household farm size was significant at 10 % and had a positive coefficient. Soil depth was significant at 10 % and positively correlated with the probability of investing. Drainage (an indicator of water retention) had a negative coefficient but was not significant. Access to agricultural extension as well as the adoption of improved technology did not significantly affect households' probability to invest.

The level of soil conservation and irrigation investment was measured by the amount (GHS) spent by the household to improve and conserve soil water or fertility and to facilitate irrigation. Households' level of investment in soil conservation and irrigation was hypothesised to be influenced by a number of household socioeconomic and farm characteristics as well as the provenance of land (Table 3). Compared to the results of the probability of investment, differences in the amounts spent by households in soil conservation and irrigation were to a large extent explained by differences in types of land use and ownership arrangements as well as the duration of land ownership.

[6] Tropical Livestock Units are livestock numbers converted to a common unit. The Conversion factors are: cattle = 0.7, sheep = 0.1, goats = 0.1, pigs = 0.2, chicken = 0.01. Factors taken from HarvestChoice (2011)

[7] Land fragmentation ratio measures the ratio of total household farm size (in acres) to the number of parcels or plots. It is an indicator of whether household land holdings are continuous large tracts or small scattered plots.

Table 2: *Maximum Likelihood Estimates of the Determinants of the Decision to Invest*

Variable	*Coefficient*	*Robust Std. Errors*	*Z*
Household Characteristics			
Sex of household head	0.4065	0.0971	4.19***
Age of household head	–0.0240	0.0091	–2.62**
Age square of household head	0.1754	0.0862	2.03*
Dependency ratio	0.0101	0.0309	0.33
Basic education	0.2133	0.0382	5.58***
No education	0.2884	0.0856	3.37**
Household Assets and Wealth variables			
Livestock Holding (in TLU)	–0.0343	0.0386	–0.89
Household land holding	–0.0156	0.0075	–2.08*
Value of output per area	0.4721	0.0886	5.33***
Family labour	0.0733	0.0342	2.14*
Land Tenure and Security Variables			
Gifted land	–0.3087	0.06015	–5.13***
Sharecropped land	–0.2323	0.0676	–3.44**
Rented land	–0.1173	0.0654	–1.79*
Ownership with deed	0.1633	0.0676	2.42*
Ownership without deed	–0.0136	0.0944	–0.14
Assurance of tenure security	0.1389	0.0554	2.50*
Years of land ownership	–4.3728	3.9281	–1.11
Crop and Location Variables			
Affram Basin	0.4404	0.0796	5.53***
Northern agricultural zone	0.7883	0.1149	6.86***
Distance to major market	–0.0140	0.0038	–3.65***
Perennial cash crops	0.0198	0.1002	0.20
Non-perennial cash crops	–0.1275	0.0625	–2.04*
Vegetables and spices	0.2350	0.0624	3.77***
Plot Characteristics			
Ratio of zonal to household farm size	0.1805	0.0877	2.06*
Index of land fragmentation	0.1829	0.0510	3.58***
Access to irrigation	0.9210	0.0710	12.96***
Drainage	–0.1371	0.3398	–0.40
Soil depth	25.8536	14.5829	1.77*
Access to Innovation and Technology			
Receive extension visits	–0.0130	0.0539	–0.24
Adoption of improved technology	0.0771	0.0498	1.55
Constant	–1.5085	0.2811	–5.37***
Log likelihood	–1866.34		
Wald χ^2 (30)	365.43		
Prob > χ^2	0.0000		
Pseudo R^2	0.1009		

Dependent Variable is the decision to invest into soil conservation and irrigation (1 if the household invested and 0 if household did not invest)
Source: Authors' computations from *MIDA FBO Survey, 2008*
*, **, and *** are levels of significance at 10 %, 5 %, and 1 %, respectively.

Table 3: *Determinants of Soil and Water Conservation and Irrigation Investment expenditure*

Variable	*Coefficient*	*Robust Std. Err.*	*t-statistic*
Household Characteristics			
Sex of household head	–102.1851	36.4605	–2.80**
Age of household head	11.6229	6.0322	1.93*
Age of household head square	–146.8364	58.7225	–2.50*
Household size	28.5339	3.9584	7.21***
Dependency ratio	–90.2414	17.4334	–5.18***
Attained basic education	–32.1379	19.5568	–1.64
No formal education	–121.8411	40.1405	–3.04**
Household Assets and Wealth variables			
Livestock holding (in TLU)	–23.8377	21.5921	–1.10
Land holding	–7.8167	4.12557	–1.89*
Non-farm income (per capita)	17.5791	10.2533	1.71*
Value of output per area	0.1187	.018828	6.31***
Family labour	19.6628	21.6363	0.91
Land Tenure and Security Variables			
Family land	–39.4991	44.0785	–0.90
Gifted land	–47.0821	45.5502	–1.03
Sharecropped land	6.1550	39.7833	0.15
Rented land	93.5805	43.5905	2.15*
Ownership with deed	150.3289	44.5321	3.38**
Ownership without deed	67.4012	37.4213	1.80*
Duration of land contract [8]	17.4348	4.15372	4.20***
Years owning land [9]	–7.1505	4.26031	–1.68*
Duration of tenure security [10]	281.6785	26.7354	10.54***
Crop and Location [11] Variables			
Afram Basin	138.6426	39.2577	3.53***
Northern agricultural zone	326.5296	63.9384	5.11***
Perennial cash crops	61.9845	58.6894	1.06
Non-perennial cash crops	–83.3227	29.2898	–2.84**
Vegetables and spices	39.7842	34.7841	1.14
Distance to major market	–1.9830	1.54175	–1.29
Plot Characteristics			
Ratio of zonal to household farm size	51.8104	50.2338	1.03
Index of land fragmentation	–36.7666	16.1320	–2.28*
Access to irrigation	258.0953	33.1152	7.79***
Drainage	213.7851	108.114	1.98*
Market Access and Participation			
Receive extension visits	88.5725	27.2893	3.25**
Adopted improved technology	35.7479	24.5838	1.45
Constant	–1062.186	206.2269	–5.15***
Log pseudo likelihood	–4034.3159		
F(38,1352)	11.30		
Prob > F	0.0000		
Pseudo R^2	0.0596		
Left-censored observations at INVSWCON_IRR ≤1	893		
Uncensored observations	459		
Observations	1352		

Dependent variable: GHS (₵) invested in soil and water conservation and irrigation.
Source: Authors' computations from *MIDA FBO Survey, 2008*
*, **, and *** are levels of significance at 10 %, 5 %, and 1 %, respectively.

Land ownership (both with deed and without deed) had significant positive effects on households' investment expenditure. Consistent with *a priori* expectations, family owned, rented, gifted and sharecropped lands had negative coefficient but were however not statistically significant.

The signs of household wealth variables were mixed in terms of their consistency with *a priori* expectations. Livestock holding (in TLU) did not have the expected positive sign even though the coefficient was not significant. Non-farm income and value of output had the expected signs and was significant at 10 % and 1 % respectively. Location dummies which were included to capture site specific effects in investment indicated that autonomous investment in soil conservation and irrigation was relatively higher in the Afram basin and the northern agricultural zone. The dummies for these two locations were significant at 1 %.

With respect to plot characteristics, the degree of land fragmentation and drainage were found to be significant in explaining the amounts households invested in soil and water conservation and irrigation. Households invested less on highly fragmented plots and more on irrigable plots and well drained plots. With regards to market and information access, farmers who received extension visits were found to invest higher amounts than those who did not. Adoption of improved technology had the expected positive sign but did not significantly influence household investment expenditure.

Some household and demographic factors seemed to significantly influence the levels of soil conservation and irrigation investments. Both age and age-squared of household head had significant effects on the amounts invested exerting positive effects on the amounts households invested in soil conservation and irrigation.

Household size was found to have a significant positive effect on the amounts invested and was significant at 1 %. Although not significant, formal education was inversely related to the amounts households invested in soil conservation and irrigation but the formal education variable was not significant. As expected however, not having formal education significantly reduced the amounts households invested in soil and irrigation.

[8] Duration of land contract refer to the number of years a land owner has agreed to allow a tenant use land in contract (formal or informal) arrangement.

[9] Refers to the number of years the farmer has owned the land. Households who have owned land for longer periods are perceived more secure.

[10] Duration of tenure security is the length of time that a given right is legally valid. The economic dimension requires, in addition, that the time horizon be sufficiently long to enable the holder to recoup (see Roth & Haase, 1998)

[11] Southern Horticultural belt is used as reference category

5 Discussion

Land documentation and duration of tenure security positively influenced households' decision to invest and is an indication that land titling programmes and policies can facilitate households' farm investment by enhancing tenure security. This finding is an indication that formalisation of land rights though not a comprehensive indicator of land tenure security, contributes significantly to enhance land holders' perception of their tenure security and their decisions to invest in lands.

Household land relative to zonal farm size was included to test for farm size effects. Contrary to the finding by Holden & Yohannes (2002), the study found that marginal farm size was inversely related with tenure insecurity. Tenure insecurity was rather found to correlate positively with value of farm land and not farm size as Alemu (1999) posited. The reason for this observation is that owning large tracts of land may not be a source of insecurity if there are no competing claims. However, as land values rise, interests in land both as a factor of production and commodity increases. Local elites who probably were not interested in land re-entered the market and may appropriate land belonging to less powerful holders.

Contrary to expectations that households that owned more livestock would invest more in land because they were regarded as wealthy (Holden & Yohannes, 2002), the reverse held. One possible explanation is the use of livestock as security against crop failure. Households may not sell their livestock to invest in land conservation and irrigation but may do so in the event of crop failure.

The expectation on the relationship between location dummies was that farmers in the southern horticultural zone would invest more because land was scarce and there was the need to maximise output. This expectation was based on the Boserup (1965) population pressure hypothesis which posits that high population density (land scarcity) would stimulate investment and use of improved technology. It was expected that the high population density of the southern horticultural belt will lead to higher propensities to invest. The absence of this population pressure effect could however be due to abundant non-farm employment opportunities in the South which significantly increases the opportunity cost of farm labour and other resources and also offer opportunities that do not require ownership of land.

The study expected that highly fragmented land (measured by the land size in acres per number of plots) would discourage investment as the prospects of commercial scale production would be limited. The findings however suggest that households' decision to invest was positively correlated with land fragmentation. This is contrary to *a priori* expectation that highly fragmented plots, usually common with communal or family held land, would have a negative effect on the probability of investing. One possible explanation for this observation is that households may be using land fragmentation as some sort of risk spreading activity. Further, land ownership overrides fragmentation in investment decision.

The results on the relationship between the monetary value of investments and tenure security variables were mostly consistent with *a priori* expectations. Farmers who owned land invested more relative to those who had acquired land through tenancy. The negative relationship between the amounts invested and the cultivation of family owned, rented, gifted and sharecropped lands could be indicative of some degree of Marshallian inefficiency (Marshall, 1890) transmitting to households' willingness to invest and levels of investment expenditure on long-term soil improvement and irrigation.

In relation to the socio-demographic factors included in the models as control variables, the results showed that age and age-squared exerted significant positive effects on the amounts invested. The expectation was that age and age-squared would have positive and negative effects respectively on the amounts invested. That would have implied younger farmers invested more in soil and water conservation and in irrigation because they constituted the most productive group and most likely to be engaged in farming for commercial reasons. The results however suggest that investment did not vary much along age lines.

Household size was positively related to the amounts invested. Large households usually cultivate larger farms and hence are more likely to invest more. Households with lower number of dependents as opposed to workers were expected to invest more because relative to households with higher dependency ratios, they would have surplus production, and the proceeds could be reinvested in farming. The negative sign of the dependency ratio variable is thus consistent with this expectation. Higher dependency ratio reduces the amount of investment in soil conservation and irrigation.

6 Conclusion

This paper explored the relationship between households' perception of their tenure security and how these perceptions influenced plot level farm investment decisions in soil conservation and irrigation. The paper measured land tenure security both in terms of right entitlements and the duration within which holders perceived the rights to be secure. The household was modelled as a utility maximizing entity that choose between short-term complementary inputs use and long-term land investments based on the household's evaluation of its land tenure security.

Findings of the paper support the long-held view that better land rights facilitate long-term farmland improvement investments. Tenure security, often posited to influence household farm investment decisions appears to hold in the case of Ghana. Individual ownership of land increased the probability of investing and the level of investments made in land improvement and irrigation. This evidence probably points to the increasing importance households place on land ownership and also underscores the importance of tenure security in facilitating land titling programmes. Several studies, especially those conducted in the middle to late twentieth century, failed to plausibly establish strong links between land ownership and investment as this study finds. Two possible explanations for this particular finding of the study are: First, there is the possibility that land markets and land relations have changed significantly over the last two decades with increasing money transaction and fixed agreements propelled by population growth and increasing value of land. Second, the inclusion of irrigation investment as a long term investment in land raises the value of household investment and also the time period required to reap the returns on the investments.

The finding of this paper seems to reinforce Boserup (1965) and Ault & Rutman (1979) predictions that land tenure in Africa evolved in tandem with principles of economic efficiency and that households would acquire full rights (i.e. take full rights into consideration) when the need for such rights arose, propelled either by population growth and land scarcity or by emerging market opportunities. It could be deduced that households take land ownership and tenancy arrangements into consideration if the resource implications of land investments are relatively huge and the time dimensions for harvesting returns to investments is relatively short.

It is recommended that for productivity to increase due to intensification, land owners should allow for long-term lease to provide the needed security that will encourage huge investment into development of land for long-term benefits.

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