The Profits of Power: Land Rights and Agricultural Investment in Ghana*

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Abstract: We examine the impact of ambiguous and contested land rights on investment and productivity in agriculture in Akwapim, Ghana. We show that individuals who hold powerful positions in a local political hierarchy have more secure tenure rights, and that as a consequence they invest more in land fertility and have substantially higher output. The intensity of investments on different plots cultivated by a given individual correspond to that individual's security of tenure over those specific plots, and in turn to the individual's position in the political hierarchy relevant to those specific plots. We interpret these results in the context of a simple model of the political allocation of land rights in local matrilineages

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1 Introduction

Institutions matter for growth and development. In particular, it is apparent that investment incentives depend upon expectations of rights over the returns to that investment and hence on the nature of property rights. In recent years, economists have paid increasing attention to this hypothesis (and brought the argument into the broader public sphere, e.g. De Soto 2000). Economic historians have provided a great deal of the evidence that bears on this hypothesis (North 1981; Jones 1987; Engerman and Sokoloff 2003). Additional evidence has been contributed from cross-country regressions of economic growth on a variety of measures of institutional quality (Acemoglu, Johnson, Robinson 2001, 2002; Easterly and Levine 2003; Hall and Jones 1999; Pande and Udry 2005). This paper joins a growing microeconomic literature that explores the pathways though which particular institutions influence investment or productivity (Besley 1995; Field 2003; Johnson, McMillan, Woodruff 2002). Our aim is to examine one particular mechanism through which the nature of the system of property rights in a society can shape its pattern of economic activity. We examine the connection from a set of complex and explicitly negotiable property rights over land to agricultural investment and, in turn, to agricultural productivity.

There are several obvious mechanisms through which property rights over land might influence investment in agriculture. Adam Smith focused attention on the possibility that cultivators' fears of expropriation or loss of control over land on which investments have been made might deter such investment.[1] In addition, access to credit might be hindered if property rights are not sufficiently well-defined for land to serve as collateral for loans; and an inability to capture potential gains from trade in improved land might reduce investment incentives. Each of these

[1] In his discussion of the Act of Ejectment, which provided for compensation for past investments when a tenant was evicted, Smith writes "when such farmers have a lease for a term of years, they may sometimes find it for their interest to lay out part of their capital in the further improvement of the farm; because they may sometimes expect to recover it, with a large profit, before the expiration of the lease. The possession even of such farmers, however, was long extremely precarious, and still is so in many parts of Europe. They could before the expiration of their term be legally outed of their lease. ... [But since the Act, in England] the security of the tenant is equal to that of the proprietor.... Those laws and customs so favourable to the yeomanry have perhaps contributed more to the present grandeur of England than all their boasted regulations of commerce taken together" (Smith 1974, Volume 1, Book III, Chapter 2).

mechanisms has received a good deal of attention in what has become an important literature. With few exceptions, however, these papers "fail to find strong evidence of significant effects of property rights on investment" (Besley 1998, 361).

In much of Africa, explicit land transactions – sales, cash rentals, sharecropping – have become more common over recent decades. However, the consensus of the literature is that "the commercialisation of land transactions has not led to the consolidation of land rights into forms of exclusive individual or corporate control comparable to Western notions of private property" (Berry 1993, 104). Instead, land "is subject to multiple, overlapping claims and ongoing debate over these claims' legitimacy and their implications for land use and the distribution of revenue" (Berry, 2001, xxi). Individuals' investments in a particular plot might in turn influence their claims over that piece of land in complex patterns: "individually rewarded land rights are further strengthened if land converters make long-term or permanent improvements in the land, such as tree planting. Land rights, however, tend to become weaker if land is put into fallow over extended periods." (Quisumbing et al., 2001, 55).

In an environment where fertilizer is expensive, land is relatively abundant and crop returns sufficiently low, fallowing is a primary mechanism by which farmers increase their yields. A significant portion of the agricultural land in West Africa is farmed under shifting cultivation, so fallowing remains the most important investment in land productivity – despite the fact that it may weaken land rights. In this paper we examine how farmers negotiate this delicate balance. We show that farmers who lack local political power are not confident of maintaining their land rights over a long fallow. As a consequence, they fallow their land for much shorter durations than would be technically optimal, at the cost of a large proportion of their potential farm output.

We provide a brief description of land tenure in southern Ghana in section 2. The primary source of land for farming is the allocation to individuals of land controlled by that individual's extended matrilineage, or *abusua*. The agronomics of intercropped maize and cassava, which is the main food crop farming system in the area, is discussed in section 3. The most important investment that farmers make in their land in the study area is fallowing, so we provide a simple model of efficient fallowing decisions to guide the first stages of our empirical work. The data and the survey from which they are drawn is described in section 4. In section 5, we show that profits per hectare on maize-cassava farms varies widely across apparently similar plots cultivated by different individuals in the same household, and that this variation can be attributed to variation in the length of time that these plots have been left fallow. We examine the determinants of fallow durations in section 6, where we show that individuals with powerful positions in local political hierarchies leave their plots fallow for years longer than do other individuals. Fallow durations vary across the different plots cultivated by a single farmer, depending upon the provenance of the land. Individuals with local political power fallow land that they obtained through the political process of matrilineage land allocation significantly longer than they do land obtained through other means. In section 7 we discuss the political economy of land allocation within a matrilineage. We construct and test a simple model in which land is redistributed to matrilineage members most in need, subject to asymmetric information regarding off-farm income. We show that the extent of one's need is imperfectly signalled by fallowing choices. The cost to an individual of obtaining land from the matrilineage is the lost output associated with the too-short fallow period that signals that person's need for the land. Section 8 concludes.

2 Land Rights in Akwapim

The complexity and flexibility of property rights in West Africa is apparent in our study area in Akwapim, Ghana. Most of the land cultivated by farmers in these villages is under the ultimate control of a paramount chief and is allocated locally through a matrilineage (*abusua*) leadership.[2] Each farmer in the area cultivates on average 4 separate plots. Land is allocated to individuals for use on the basis of his or her political influence and perceived need.

There is a rich literature that describes the land tenure systems of southern Ghana. The most general principle is that land is 'owned' by the paramount chieftaincy (known as the *stool*), and is controlled by a particular *abusua* subject to the *abusua*'s membership meeting their continuing obligations as subjects of the stool. Individuals, in turn, have rights to the use of farm land by virtue of membership in an *abusua*.[3]

[2] This is not to say other forms of ownership/contracts over land do not exist. We discuss these less prevalent forms of tenure later.

[3] There are numerous descriptions of this principle. See Amanor (2001, pp. 64-76), Klingelhofer (1972, p. 132),

This general principle does not define *which* individual member of an *abusua* will cultivate which particular plots. Individual claims over land overlap. Who ends up farming a specific plot is the outcome of a complex, sometimes contentious, process of negotiation. Moreover, land rights are multifaceted. The act of cultivating a given plot may – or may not – be associated as well with the right to the produce of trees on the land, the right to lend the plot to a family member, the right to rent out the land, the right to make improvements, or the right to pass cultivation rights to one's heirs. A person's right to establish and maintain cultivation on a particular piece of land, and the extent of her claims along the many dimensions of land tenure are ambiguous and negotiable. The situation is further complicated by the tension between matriliny and patriliny as fathers attempt to transfer land rights to their own children, outside inheritance norms (McCaskie, 1995, pp 77, 277-78; Austin, 2004, p. 174). As a consequence, "people's ability to exercise claims to land remains closely linked to membership in social networks and participation in both formal and informal political processes" (Berry, 1993, p. 104). To summarize, while

> "[i]n principle, any individual is entitled to use some portion of his or her family's land, ... people's abilities to exercise such claims vary a good deal in practice and are often subject to dispute. Disputed claims may turn on conflicting accounts not only of individuals' histories of land use, field boundaries, or contributions to land improvements but also their status within the family, or even their claims of family membership itself." (Berry, 2001, p. 145).[4]

Berry (2001, pp. 146-156), Austin (2004, p. 100), Wilks (1993), Rattray (1923, pp. 224-241).

[4] This general pattern of negotiated access to land through membership in a corporate group is found elsewhere in Ghana, in many parts of West Africa and in some other areas of Africa, although there is considerable variation in the details. Some examples can be found in Fred-Mensah (1996), Biebuyck (1963), J. Bruce and S. Migot-Adholla, eds. (1994), Binswanger, Deininger and Feder (1995), Bassett (1993), Peters (1994), Bromley (1989), Amanor (2001), Sawadogo and Stramm (2000). Summarizing the conclusions of several studies from across the continent, Bassett and Crummey state:

> " the process of acquiring and defending rights in land is inherently a political process based on power relations among members of the social group. That is, membership in the social group, is, by itself, not a sufficient condition for gaining and maintaining access to land. A person's status ... can and often does determine his or her capacity to engage in tenure building. (Bassett and Crummey,

In our sample, there are a number of individuals (about 15% of the sample) who hold an office of social or political power in their village or *abusua*. Typical offices include lineage head (*abusuapanyin*), chief's spokesman (*okyeame*), lineage elder or subchief. These are not formal government positions. They instead represent positions of importance within local political hierarchies. In accordance with the conclusions of other observers, we find in Table 1 that such individuals are far more confident than typical farmers of their rights over their cultivated land. Of course, these are their own claims about their rights along a limited number of dimensions; below, we examine the relationship between such political power and output and investment decisions on these plots.

A cultivator's rights over her growing crops, on the other hand, are quite secure. Wilks summarizes the principle as "afuo mu *yɛ deɛ*, asase *yɛ* ohene *deɛ*" ("the cultivated farm is my property, the land is the stool's" (1993, p. 99).[5] Plots are virtually never lost while under cultivation. The impact of the particular form of tenure insecurity that exists in Ghana on certain types of investment, especially tree planting, might be quite minimal.[6] Planting a tree, building a structure, or improving drainage might help cement a person's claim to a plot (Besley 1995).

On the other hand, in the farming system we consider, the most important investment in land quality is leaving land fallow in order to permit soil fertility to regenerate. It is during this period of fallow that one's rights over a plot can be lost.[7] "Because of tenure insecurity under traditional land tenure institutions, there is no strong guarantee that the cultivator can keep fallow land for his or her own use in the future." (Quisumbing et al., 2001, pp. 71-72). Accordingly, we suppose that the possibility that land might be lost while fallowed leads farmers to reduce the duration of the fallow period. It is the nexus of a particular form of investment and these complex and negotiable land rights that has dramatic consequences for the overall

1993, p. 20)

[5]This principle is also supported in the formal court system: "Since colonial times, the courts have held that while allodial rights to land belong to the stool, families' rights of usufruct are secure from arbitrary intervention." (Berry, 2001, p. 145, citing N.A. Ollenu and G.R. Woodman, eds., *Ollenu's principles of customary law.* 2nd ed).

[6]See Austen (2004) and Pande and Udry (2005) for discussions of the interactions between this land tenure system and the 20th century cocoa boom in Ghana.

[7]See Firman-Sellers (1996, p. 65), Austin (2004, pp. 333-346).

efficiency of the farming system.

3 Resource Management and Land Tenure

We restrict attention in this paper to the main food crop farming system in the study area, which is an intercropped mixture of maize and cassava. Approximately three-quarters of the plots cultivated in our study area are planted with these crops. This mixture became the focus of agriculture in the Akwapim region by the 1950s, after swollen shoot disease devastated cocoa production. In addition to maize and cassava, farmers in these villages also cultivate pineapple for export as a fresh fruit, and a variety of other, more minor crops.

Soil fertility in the maize and cassava farming system in southern Ghana is managed primarily through fallowing: cultivation is periodically stopped in order for nutrients to be restored and weeds and other pests to be controlled.[8] This farming system has a particularly stark form of fertility maintenance through fallowing. Farms are cleared from a bush fallow and the cleared brush is burnt. The newly-cleared plot is cultivated for a single cycle of cassava and maize – long enough for one harvest of cassava and two of maize. The cassava harvest often continues over a period of many months, ending approximately 2 years after the initial clearing of the plot. After the cassava is harvested, the plot is returned for another period of fallowing.[9] Of 519 plots in our sample, only 61 have been in cultivation for more than three years. In most cases, cultivation continues on these plots because they are primarily orchards with tree crops; in a few instances these are small garden plots under permanent cultivation near the house. We observed no instance of chemical fertilizers being used to maintain soil fertility on maize-cassava plots, although fertilizer is frequently used on the pineapple farms cultivated by some of these households.

Soil scientists working in the area argue that fallow durations of approximately six to eight years is sufficient to maintain soil fertility in this farming system (de Rauw 1995, Nweke 2002). Ahn (1979) argues that

> under forest conditions, both soil organic matter changes and the transition from

[8] Amanor (1994, chapter 6) has a useful discussion of fallowing and soil fertility in Krobo, near our study area.

[9] This corresponds to the "short fallow" system with one cycle of cultivation described by Nweke, Spencer and Lynam (2002). This is the dominant system for cassava cultivation in Africa.

> thicket of young secondary forest re-growth suggest that, in many areas, a fallow of 6-8 years is a desirable practical minimum: below this the soil will be maintained by successive fallows at a lower organic matter level and level of productivity.

The median duration of fallow in the plots in our sample is 4 years; the 90th percentile of fallow durations is 6 years. To anticipate results to follow, the final column in Table 1 shows that plots cultivated by individuals who hold local offices are more likely to have been fallowed for at least 6 years than are plots cultivated by others.

In southern Ghana, as in many African societies, agricultural production is carried out on multiple plots managed separately by individuals in households. An individual's decisions regarding the optimal time path of fertility and of agricultural output from a given plot in such a system depend, *inter alia*, on the opportunity cost of capital to that individual and his or her confidence in her ability to re-establish cultivation on the plot after fallowing.

Consider an individual i (in household h) with control over a set P of plots of land (indexed by p). We assume that $i's$ aim is to manage fertility to maximize the present value of the stream of profits she can claim from this land.[10] The salient decision facing this individual is the length of time she should leave each plot fallow before cultivation. Considered in continuous time in a stationary environment, this corresponds precisely to the optimal harvest problem solved long ago by Faustmann (1849).

Suppose that the profit (per-hectare) that can be generated from cultivating a plot depends upon the time that the plot has been left fallow according to the strictly concave and increasing function $\pi_p(\tau)$, where τ denotes the length of the fallow period. If we denote by ρ_h the household-specific discount rate, and by ω_p the instantaneous likelihood of losing the plot while

[10] In general, of course, this assumption is consistent with utility maximization only if factor and insurance markets are complete (Krishna 1964; Singh, Squire and Strauss 1986). However, we will focus on comparisons across plots within households, and also across different plots cultivated by the same individual. If households are Pareto efficient (as in Chiappori (1988)), then by the second welfare theorem there exist (household-specific) shadow prices such that fertility management decisions correspond to those that maximize the present discounted value of the stream of profits at those shadow prices. Similarly, when we examine fertility decisions across plots of a particular individual, we will be assuming that the allocation of resources across plots cultivated by that single individual is Pareto efficient. In this case, there are individual-specific shadow prices such that the PDV of the stream of profits from each of the individual's plots is maximized.

it is fallow, then the value of profits from $i's$ plots is

$$\sum_{p\in P}\pi_p(\tau_p)\sum_{n=1}^{\infty}e^{-n(\omega_p+\rho_h)\tau_p}=\sum_p\pi_p(\tau_p)\frac{e^{-(\rho_h+\omega_p)\tau_p}}{1-e^{-(\rho_h+\omega_p)\tau_p}}. \tag{1}$$

The individual maximizes (1) with respect to τ_p. Let $\pi'_p(\tau)$ denote the first derivative of the profit function. The concavity of $\pi_p()$ ensures a unique optimal fallow duration for each plot (τ_p^*), which is defined implicitly by

$$\frac{\pi'_p(\tau_p^*)}{\pi_p(\tau_p^*)}=\frac{\rho_h+\omega_p}{1-e^{-(\rho_h+\omega_p)\tau_p^*}}. \tag{2}$$

The optimal fallow duration falls with increases in the likelihood that the individual will lose the plot, and with the discount rate. It is apparent from (2) that for any two plots p and q cultivated by the same individual, if they are similarly securely held ($\omega_p=\omega_q$) and have similar physical characteristics ($\pi_p(\tau)\equiv\pi_q(\tau)$), then the optimal fallow durations are the same on each plot ($\tau_p^*=\tau_q^*$). The same holds for any two plots within a given household, if the household is Pareto efficient.[11]

[11] This general message is robust to imperfect markets which provide an incentive for individuals to adjust harvest periods to smooth factor demand. Consider, for example, a simple discrete time model and a household with two plots. In any given year, if the household cultivates one plot that had been fallowed the previous year, it earns Y. If it cultivates both plots, each having been fallowed, it earns only θY from each plot, $\theta<1$. This reflects the costs of extending cultivation beyond the single plot where labor or other input markets are imperfect. If a plot was not left fallow the previous year, it yields δY, $\delta<1/2$ (so fallowing is potentially productive). If two unfallowed plots are cultivated, total return is $2\delta\theta Y$, if one unfallowed and one fallowed plot are cultivated, the return is $\theta Y(1+\delta)$. Let the state variable $s\in(0,1,2)$ denote the number of plots fallowed last period. The discount factor is β, and the household is risk-neutral and maximizes the discounted stream of future returns. The value functions v_s are

$$\begin{aligned}v_2&=\max\{\beta v_2,Y+\beta v_1,2\theta Y+\beta v_0\}\\ v_1&=\max\{\beta v_2,Y+\beta v_1,\theta Y(1+\delta)+\beta v_0\}\\ v_0&=\max\{\beta v_2,\delta Y+\beta v_1,2\delta\theta Y+\beta v_0\}\end{aligned}.$$

The choices in each maximand correspond to fallowing 2, 1 or 0 plots, respectively. Depending upon parameter values, there are a number of possible equilibria. The interesting case is the two equilibria

$$\begin{aligned}&0\to 2,1\to 1,2\to 1\\ &0\to 0,1\to 1,2\to 1\end{aligned}.$$

In the first pattern, the equilibrium of cultivating one of the two plots each year rapidly emerges, regardless of the initial state of fallowing. However, for sufficiently low β, the second pattern emerges. If the cultivator starts

Given imperfect financial and labor markets in rural Ghana, it is unlikely that the opportunity costs of capital or labor are identical across plots cultivated by individuals in different households. However, they will be the same across plots cultivated by the same individual, and if households allocate resources efficiently across household members, then they will be identical across plots within households. These observations form the basis of our initial empirical work.

4 The Data and Empirical Setting

The data in this paper come from a two year rural survey in the Akwapim South District of the Eastern Region of Ghana.[12] We selected four village clusters (comprising 5 villages and two hamlets) with a variety of cropping patterns and market integration. Within each village cluster we selected 60 married couples (or triples - about 5 percent of the sample is polygynous) for our sample. Each head and spouse was interviewed 15 times during the course of the two years. Every interview was carried out in private, usually by an enumerator of the same gender.

The survey was centered around a core group of agricultural activity questionnaires (plot level inputs, harvests, sales, credit) that were administered during each visit. The purpose of this high frequency was to minimize recall error on reports of plot-level inputs and outputs. In addition about 35 other modules were administered on a rotating basis. We also administered an in-depth plot rights and history questionnaire and mapped each plot using a GPS system. We supplemented this with data on soil fertility: the organic matter and pH of approximately 80 percent of the plots was tested each year. We also make use of data on education and individual wealth, which is possible to collect because of the quite separate accounts that are kept by husbands and wives.

Table 2 reports summary statistics on the variables we use in this paper's analysis. Plot profits are calculated with household labor valued at gender-village-survey round specific median wages. Given that we are examining the role of political power in tenure security, we have separated the summary statistics by the office holding status of the individual. Average per-hectare profits and yields are comparable on the plots cultivated by office holders and non-office

with none of her plots fallowed ($s = 0$), she is sufficiently impatient that she does not ever begin fallowing. The key point is that in the steady state of *any* equilibrium, each similar plot is treated identically.

[12] The data and documentation are available at www.econ.yale.edu/cru2.

holders, but office holders cultivate larger plots. Inputs and measured soil organic matter and pH of plots is similar across office-holding status. The average duration of the last fallow period is almost a year longer for office holders, and office holders have had control over their plots for much longer than non-office holders. Office holders are significantly more likely to be cultivating plots that come from their own *abusua* than are others. There is some indication that office holders cultivate fewer plots obtained through commercial transactions. Approximately half of these commercial transactions are sharecropping contracts, and half are based on fixed rent.

Office holders are much more likely to male, and are older, richer and better educated than other farmers in their villages. Their mothers were more likely to be farmers, and their fathers had more wives. They are less likely to be the first of their family to settle in the village, and their families have lived in the village for longer. They claim to have inherited more land (although we are skeptical about the accuracy of this particular variable, because we were not able to physically measure the area claimed to be inherited, and farmer estimates of the areas of the plots they do cultivate were extremely inaccurate (Goldstein and Udry 1999)). The parents of office holders were less likely to have been educated than others in the village, perhaps reflecting the reluctance of some traditional leaders to the introduction of western schooling.

5 Productivity in a Fallow Farming System

If households allocate resources efficiently, then the marginal value products of inputs used on farm operations are equated across plots within households. We do *not* assume that input costs or the opportunity cost of capital is similar across households. Within the household, plots of similar fertility should be cultivated similarly. Moreover, we have seen that the optimal fallowing path does not vary across plots within the household, so in the efficient allocation τ^* varies across plots only if those plots vary in their physical characteristics or in the security with which they are held.

So we can define profits on plot p cultivated by individual i in household h at time t as a function only of the characteristics of that plot:

$$\pi_t(\tau_p^*, X_p) \tag{3}$$

where X_p is defined as a vector of fixed characteristics of plot p and τ_p^* is the duration of the last fallow on plot p. A first-order approximation of the difference in profits across plots within a household is

$$\pi_t(\tau_p^*, X_p) - \pi_t(\bar{\tau}_{h_p}, \bar{X}_{h_p}) \approx \frac{\partial \pi_t}{\partial \tau}(\tau_p^* - \bar{\tau}_{h_p}) + \frac{\partial \pi_t}{\partial X}(X_p - \bar{X}_{h_p}). \tag{4}$$

h_p is the household in which the cultivator of plot p resides, and bars indicate averages of characteristics over the plots cultivated by household h_p.

We rewrite (4) as

$$\pi_{pt} = \alpha \tau_p^* + \mathbf{X}_p \beta + \gamma G_p + \lambda_{h_p,t} + \varepsilon_{pt}, \tag{5}$$

where α is $\frac{\partial \pi_t}{\partial \tau}$, β is $\frac{\partial \pi_t}{\partial X}$ and G_p is the gender of the individual who cultivates plot p. $\lambda_{h_p,t}$ is a fixed effect for the household-year. ε_{pt} is an error term (that might be heteroskedastic and correlated within household-year groups) that summarizes the effects of unobserved variation in plot quality and plot-specific production shocks on profits. An exclusion restriction of the model is that $\gamma = 0$. In an efficient household, the identity of the cultivator is irrelevant for profits.

Within the vector $\mathbf{X}_p$ we include a variety of plot characteristics – size, toposequence, direct measures of soil quality (the soil pH and organic matter content) as well as the respondent-reported soil type classified into clay, sandy or loam. These soil types might affect profits and inputs through their different nutrient retention capacities, among other factors.

(2) implies that τ_p^* is chosen optimally. We can expect τ_p^* to be correlated with ε_{pt}, even conditional on $\lambda_{h_p,t}$. Therefore, based on the discussion of section 2, we collected a set of variables that represent the cultivator's position in local social and political hierarchies. These variables might influence her tenure security and thus her choice of optimal fallow duration, and we estimate (5) using these as instrumental variables.

5.1 Fallowing and Within-Household Productivity Variation

We begin by assuming that there is no variation in tenure security across plots in our sample. In this case, (2) implies that optimal fallow duration τ_p^* is a function only of X_p and household-specific shadow prices. (3) becomes $\pi_t(\tau(X_p), X_p)$, where $\tau(.)$ is defined implicitly by (2) evaluated at ρ_h. Within-household differences in plot profits (4) depend only on differences in plot characteristics:

$$\pi_t(\tau(X_p), X_p) - \pi_t(\tau(\bar{X}_{h_p}), \bar{X}_{h_p}) \approx \left(\frac{\partial \pi_t}{\partial \tau}\frac{\partial \tau}{\partial X} + \frac{\partial \pi_t}{\partial X}\right)(X_p - \bar{X}_{h_p}). \tag{6}$$

Accordingly, we modify (5) and estimate

$$\pi_{pt} = \mathbf{X}_p\tilde{\beta} + \tilde{\gamma}G_p + \tilde{\lambda}_{h_p,t} + \tilde{\varepsilon}_{pt}, \tag{7}$$

in which $\tilde{\beta}$ both the direct and the indirect (through fallowing choice) effect on plot profits of variation in plot characteristics. The exclusion restriction $\tilde{\gamma} = 0$ remains in force, under the null hypothesis that there is no variation in tenure security across plots.

We present estimates of (7) in Table 3. Recall that the interpretation of the results is in terms of deviations from household-year means for cassava-maize plots. We do not expect returns to be equalized across households or years because of imperfect factor markets within villages. Column 1 presents ordinary least squares results.[13] The most striking result concerns gender: women achieve much lower profits than their husbands. Conditional on household-year fixed effects and on the observed characteristics of their plots, women get 860 thousand cedis less in profits per hectare then their husbands. Average profits per hectare are approximately 500 thousand cedis, so this is a very large effect. Given diminishing returns and the assumption that tenure security is the same across plots, a systematic difference in the returns to cassava/maize cultivation on similar plots of men and women *within* a household in a given year appears to violate the hypothesis of Pareto efficiency within households. This is the same result found in some other West African contexts (Udry 1996; Akresh 2005).

One possible explanation for the gender differential in farm profitability is that women farm plots that are of lower exogenous quality than their husbands. In column 2, we add additional information on soil quality, in the form of data on the soil pH and organic matter content

[13]The standard errors in all our specifications use limiting results for cross section estimation with spatial dependence characterized by physical distance between plots plots. Spatial standard errors are calculated using the estimator in Conley (1999) with a weighting function that is the product of one kernel in each dimension (North-South, East-West). In each dimension, the kernel starts at one and decreases linearly until it is zero at a distance of 1.5 km and remains at zero for larger distances. This estimator allows general correlation patterns up to the cutoff distances.

measured on most plots.[14] Differences in this dimension of measured soil quality do not help explain the gap in profits between husbands and wives.

It is possible that the plots of husbands and wives are physically systematically different from each other along dimensions that we do not observe. The different profitability of their plots might be a consequence of these unobserved differences in fundamental plot characteristics. These unobserved differences in physical characteristics might have to do, for example, with variations in soil physical structure or quality that are finer than we observe or with differences in moisture or patterns of water run-off. In the Akwapim region, these relatively fine physical characteristics of land tend to vary gradually over space. Plots close to each other (within a few hundred meters) are more likely to be very similar than are plots separated by larger distances. See Figure 1 for a map of the plots in one of the villages, this map also shows the houses (as stars) and paths. The other villages are organized similarly.

Therefore, we generalize (7) to permit a local neighborhood effect in unobserved land quality that could be correlated with gender and the other regressors. With some abuse of notation, let N_p denote both the set of plots within a critical distance of plot p and the number of such plots. We construct a within estimator by differencing away these spatial fixed effects:

$$\begin{aligned} \pi_{pt} - \frac{1}{N_p}\sum_{q \in N_p} \pi_{qt} &= (\mathbf{X}_p - \frac{1}{N_p}\sum_{q \in N_p} X_q)\tilde{\beta} + \tilde{\gamma}(G_p - \frac{1}{N_p}\sum_{q \in N_p} G_q) \\ &\quad + \tilde{\lambda}_{h_p t} - \frac{1}{N_p}\sum_{q \in N_p} \tilde{\lambda}_{h_q t} + \tilde{\epsilon}_{pt} - \frac{1}{N_p}\sum_{q \in N_p} \tilde{\varepsilon}_{qt}. \end{aligned} \tag{8}$$

In column 3 of Table 3 we define the geographical neighborhood of each plot using a critical distance of 250 meters. If the component of unobserved land quality that is correlated with the regressors in (8) is fixed within this small neighborhood, then the spatial fixed effect estimator removes this potential source of bias. Wives achieve much lower profits than their husbands, even on plots that are within 250 meters of each other.

Husbands and wives achieve very different profits on plots that share very similar fundamental characteristics. However, these estimates neglect the anthropogenic differences in soil fertility that emerge due to the varying fallowing histories of their plots. If tenure security is

[14] We lose some plots because of the administrative difficulties of conducting such a large number of soil tests. In addition, soil pH and OM content are likely to respond to fallowing decisions; hence, in most of the results that follow these variables are excluded.

not the same on all plots, and this variation is correlated with gender, then fallowing choices might systematically vary across plots that otherwise look similar. Hence, in Table 4 we present estimates of equation (5).

The entire difference between profits on husbands' and wives' plots is attributable to the longer fallow periods on men's plots. In column 1, we show that conditional on fallowing choices, there is no gender differential in profits within households. Instead, we find a strong positive correlation between fallow periods and profits: each additional year of fallowing is associated with about 400 thousand cedis additional profits per hectare. This is a very large effect, given a standard deviation of fallowing of about 3 years.

The optimal duration of fallowing on a plot depends on unobserved plot and individual characteristics, and so is treated as endogenous in (5). These are instrumental variables estimates, with household-year fixed effects. We use a variety of measures of the social and political family background of the cultivator as instruments for the duration of the most recent fallow. In section 2, we saw that an individual's security of tenure security on a given plot is influenced by his/her position in local social and political hierarchies. Hence, we use two indicators of the length of time the cultivators' household has been resident in the village, an indicator that the individual holds an office of local social or political power, the number of wives of the individual's father and the parity of the individual's mother in that set of wives, the number of children of the individual's father, an indicator of whether the individual was fostered as a child, and measures of the education of the individual's parents as instruments for fallow duration.

The results of the first stage regression are presented in column 2 of Table 4. The instruments are jointly significant determinants of the duration of fallow on a plot. Office holders fallow their plots for much longer than others, and people born into a better family position (a father with many wives, but relatively few children, and a mother who is one of the first wives) fallow their plots for longer. We interpret this first stage regression as preliminary evidence that the local social and political status of individuals does influence their security of tenure, and that this in turn permits them to leave plots fallow for longer periods of time.

As before, there is a potential concern with unobserved variation in exogenous plot characteristics. If these unobserved characteristics are correlated with the social and political status of the cultivator, then the IV estimator is inconsistent. It is possible, for example, that office holders get land that is better than average and that output is higher on those plots. If it is also the case that these plots are left fallow for longer periods (perhaps for reasons orthogonal to productivity), then we could see the pattern of results displayed in columns 1 and 2. Therefore, we estimate (5) with spatial fixed effects as well in columns 3 and 4. The strong effect of fallow durations on plot level profits remains apparent conditional on these spatial fixed effects, and again we cannot reject the hypothesis that husbands and wives achieve similar profits on similar plots, once we condition on fallow duration.

We saw in Table 2 that office holders tended to be older than other cultivators. In column 5, we show that neither age nor education accounts for any of the difference in profits per hectare on plots that have longer fallow durations.

5.2 How Inefficient is Fallowing in Ghana?

In a fully efficient allocation within a village, fallow durations would be the same on all similar plots (by (2), noting that shadow prices are the same across plots within an efficient allocation). Even if shadow prices vary across households because of other imperfections in factor markets, similar plots within a household should be fallowed similarly. However, we see in columns 2 and 4 of Table 4 that even within households fallow durations vary according to the position of the individual in local political and social hierarchies. It would be useful to have an estimate of the costs of this variation in fallowing choices.

The linear approximation to the profit function presented in Table 4 implies that per-hectare profits can be increased without limit for sufficiently long fallow periods. Since this is not possible, we estimate a profit function that is potentially concave in fallow duration. The simplest procedure would be to estimate a profit function that is quadratic in fallow duration; unfortunately our efforts to do so are unsuccessful, as shown in column 1 of Table 5.

Our data do not contain sufficient information to detect the degree of concavity of the profit function without additional aid. We observed in section 3 that soil scientists working in the region conclude that a fallow duration of $6-8$ years is sufficient to maintain soil fertility. Therefore, we impose the restriction that fallow durations of longer than seven years have no further impact on profits. We estimate the profit function

$$\pi_{pt} = \mathbf{X}_p\beta + g(\tau_p) + \lambda_{h_p,t} + \epsilon_{pt}, \tag{9}$$

where the contribution of fallow duration (τ_p) to profits is

$$g(\tau_p) = \begin{cases} a\tau_p^b - \frac{7ab}{b-1}\tau_p^{b-1} & for\ \tau_p \leq 7 \\ a7^\beta - \frac{7ab}{b-1}7^{b-1} & for\ \tau_p > 7 \end{cases} . \tag{10}$$

This is a conventional power function in which variations in a and b change the slope and concavity of the relationship between fallowing and profits. The second term simply ensures that the derivative of the function is 0 at $\tau_p = 7$. As a robustness check, we also estimate the alternative logarithmic function

$$g(\tau_p) = \begin{cases} a\ln(\tau_p + b) - \frac{a}{7+b}\tau_p & for\ \tau_p \leq 7 \\ a\ln(7 + b) - \frac{a}{7+b}7 & for\ \tau_p > 7 \end{cases} . \tag{11}$$

Note that neither of these specifications of $g(\tau)$ impose the restriction that g is concave, or even increasing, only that its derivative is 0 for $\tau \geq 7$. The results are reported in columns 2 and 3 of Table 5, and more informatively in Figure 2.[15]

Without knowledge of the opportunity cost of capital for households, it is of course impossible to calculate the optimal fallow duration from this estimate of the profit function. However, we can calculate the implied rates of return to fallowing an additional year implied by these estimates.[16] Increasing fallow durations from 4 to 5 years has a return of 50% for log specification, and a return of 19% for the power specification. Further increases in fallow durations have much lower returns: 16% and 6% for the log and power specifications, respectively.

Suppose all farmers adjusted fallow durations to 5 years. What is the implication of our estimates for the consequent change in steady-state aggregate profits for the maize-cassava farming system in the study area? We calculate the steady-state gain on plot p as

$$\frac{2}{7}\hat{g}(5) - \frac{2}{2+\tau_p}\hat{g}(\tau_p) \tag{12}$$

[15] In both cases, equation (9) is estimated by nonlinear least squares. Differencing (9) across any two plots within household-year groups eliminates the fixed effect $\lambda_{h_{ip},t}$. The differenced equation is estimated for all pairs of the $n_{h_{ip},t}$ plots in that household-year group with weights proportional to

$$\frac{1}{n_{h_{ip},t} - 1} \cdot \frac{n_{h_{ip},t}!}{2 \times (n_{h_{ip},t} - 2)!}.$$

[16] We add a constant term to (9) so that mean profit across the distribution of observed fallow periods matches the mean profit observed in the sample.

where the $\frac{2}{7}$ and $\frac{2}{2+\tau_p}$ acknowledge the fact that the plot is cultivated for 2 years in each complete fallow cycle. The average gain in profits associated with this change are large: 456 thousand cedis per hectare if the log specification of $g()$ is correct; 672 thousand cedis if the power specification is correct. These numbers are large even compared to gross output of maize and cassava per hectare, which is 1225 thousand cedis. If the estimates of (9) are approximately correct, then there is a very large loss of agricultural profit associated with inefficient fallowing.

A speculative calculation can help to put this into a broader perspective. Approximately 434,000 hectares of Ghana's farmland is planted to maize and cassava and located in regions where we might expect the land tenure system to be similar[17]. If the yield losses from inefficient fallowing are similar on all of this land, then we estimate the aggregate costs at 198 billion cedis (log specification) or 292 billion cedis (power specification). This translates into 1.4 to 2.1% of the 1997 GDP, for the log and power specification respectively[18]. Another perspective on this magnitude is provided by the depth of poverty in Ghana. The aggregate yield loss in these 4 regions is approximately 13 to 19% (for the log and power specifications respectively) of the *national* poverty gap.[19]

6 Determinants of Investment in Land

In this section we examine more carefully the determinants of this variation in fallowing choices across plots. First, we examine the hypothesis that individuals (within a household) of different social and political status face different opportunity costs of capital, and that these differences induce them to choose different fallow durations. Second, we show that the fallowing variation

[17] The regional breakdown of farming area comes from "Special Report: FAO/WFP Crop and Food Supply Assessment Mission to Northern Ghana", FAO 13 March 2002. We use area planted to maize and cassava figures from 2000 for the Western, Central, Eastern and Ashanti regions. As per personal communication with the Ministry of Food and Agriculture, we use the larger of maize or cassava area figures to account for intercropping (this biases the area figure downward as it excludes some single cropped fields).

[18] GDP figures come from the World Bank's World Development Indicators database.

[19] The poverty gap is the amount which, if perfectly targeted, would bring all the poor to the poverty line. Using 1998 national household survey data (the Ghana Living Standards Survey, round 4), the poverty gap is estimated at 14% of the poverty line. We can use this figure to calculate the aggregate poverty gap, which is about 1.55 trillion cedis (converting the 1998 cedis to 1997). This is based on a poverty line of 688,401 cedis per capita. We are grateful to Kalpana Mehra for these statistics.

is observed exclusively on plots that are allocated through the matrilineage political process, which leads us to focus in section 7 on the political economy of the *abusua*. Finally, we look across the different plots cultivated by a given individual to examine the hypothesis that fallowing decisions are influenced by the varying security with which different plots are held.

6.1 Wealth and Fallowing

We begin by examining the hypothesis that office holders fallow their plots more than others because they face a lower opportunity cost of capital. It is plausible that if this hypothesis is correct that (within a household) relatively wealthy individuals are less credit constrained and therefore choose longer fallow periods. We are able to measure individual wealth holdings because in West Africa most nonland assets are held by individuals, rather than by households. Wealth in this exercise is defined as the value of individual holdings of financial assets, stocks of agricultural inputs and outputs, stocks of goods for trading, physical assets and working capital of individual businesses, livestock, farm equipment and consumer durables.

Of course, individual wealth may be correlated with unobserved characteristics of the plots cultivated by the individual. Therefore, we estimate the determinants of the duration of the last fallow period treating current wealth as endogenous, using the occupational background of the cultivator's parents as instruments for wealth. The relevant conditioning information includes all the measures of the social and political background of the cultivator that appeared in Table 4, including the amount of inherited land, traditional office-holding status, and migratory history. The identification assumption is that conditional on these other dimensions of the cultivators background, parental occupation influences fallowing decisions only through its effect on wealth.

The first stage estimates of the determinants of current wealth are reported in column 2 of Table 6. The instruments are jointly highly significant determinants of current wealth. Current wealth is much lower if the cultivator's mother was a farmer, rather than the excluded category of trader (or a few other miscellaneous occupations). Current wealth is much higher if the cultivator's father had an office job, and somewhat higher if the cultivator's father was a farmer, relative to the excluded category of laborer/artisan. Several of the conditioning variables are also strongly related to current wealth: current wealth is strongly positively correlated to the number of wives of the father and to the parity of one's own mother in that set, and negatively related to the number of children of one's father. Individuals whose families have recently migrated to the village tend to be wealthier, and those who were fostered as children poorer. As we saw in the summary statistics, office holders tend to be wealthier than others.

Current wealth is well-determined by the occupations of one's parents, but in turn has nothing to do with fallowing decisions. In column 1 we present the fixed-effect (spatial and household) instrumental variables estimates of the determinants of fallow duration with current wealth treated as endogenous. The coefficient on current wealth is quite precisely estimated to be near zero: the point estimate implies that individuals with $1,000,000$ cedis in additional wealth (mean wealth is $700,000$ cedis) reduce the fallow duration on their plots by about a month, and the coefficient is not significantly different from zero. Moreover, the estimated impact of officeholding on fallowing decisions is unchanged from our earlier spatial fixed-effect specification. These results provide no support for the hypothesis that variations within the household in the cost of capital lie at the root of variations in fallowing across the plots cultivated by household members.

In column 3, we examine another dimension of wealth: the total land area controlled by the individual (minus the area on the plot under consideration). We find that fallow durations are decreasing in the total area controlled by the individual. The standard deviation of area on other plots is approximately 1 hectare; increasing area by that magnitude is associated with a relatively small but statistically significant decline in fallowing of approximately 2 months. This result should be treated with great caution, because it is plausible that the total area cultivated by an individual is correlated with unobserved variables that influence fallowing choices. Unfortunately, we cannot construct a theoretical argument for the existence of variables that influence the area of land cultivated by each individual that do not also influence that individual's tenure security and thus fallow duration. However, we can see from these results that the strong effect of officeholding on fallowing durations is not a simple consequence of office holders having more land, and therefore mechanically fallowing land for longer.

6.2 Fallowing and the *Abusua*

All land in our sample can be traced to a specific *abusua*, whether it was allocated through the *abusua* - based political process of land allocation or not. Approximately sixty percent of the plots in our sample are controlled by the matrilineage of the cultivator (Table 2). There are several mechanisms through which individuals can come to be cultivating plots that are not of their own matrilineage. Most commonly, this occurs as a consequence of a commercial transactions, or because the land is obtained from one's spouse or father, who are often members of a different matrilineage. We hypothesize that holding a local political office is particularly effective in improving an individuals security of tenure over those plots that are allocated through the political process of allocating *abusua* land as described in section 2.

In column 1 of Table 7, we present a household- and spatial-fixed effects regression of the determinants of fallow duration focusing on the provenance of the plot, and its interactions with the political status of the cultivator. The estimates show that the fallowing differential that we observe between those who hold a local political office and those who do not occurs only on land that is allocated through the *abusua*. On land obtained commercially or through immediate family, there is no statistically significant difference between the fallowing behavior of officeholders and other individuals. For non-officeholders, there is no statistically significant difference between the fallow durations on plots that they cultivate that originate in their own *abusua* and on those plots obtained from other sources. However, on land allocated by the *abusua*, officeholders have fallow durations that are more than 3 years longer than non-officeholders.

We saw in Table 1 that individuals with local offices expressed more confidence in their rights over their plots, and Tables 4 and 6 show that these office holders fallow their land for much longer than other individuals. The results in Table 7 show that variations in fallowing choices associated with local political status are limited to *abusua* land. As a consequence, we explore in greater depth the process of land allocation in the matrilineage in section 7.

6.3 Within Cultivator Effects: Tenure Security and Fallowing

The complexity and ambiguity of land rights in the study area was discussed in section 2. One consequence of this complexity is that individuals commonly cultivate plots obtained from a variety of sources and through a variety of arrangements. This variety permits us to examine the within-cultivator determinants of fallowing behavior. The key advantage of this strategy is that we can distinguish between determinants of fallowing that operate at the individual level, such as the shadow costs of factors of production or unobserved ability, and those that might operate at the level of the plot×cultivator interaction, such as the security of tenure over a given plot.

In column 2 of Table 7, we show that fallow durations vary across the plots of a given cultivator, depending upon the source of the plot (these are also conditional on spatial fixed effects). The excluded category in this regression is the set of plots obtained via non-commercial arrangements, from individuals who are not close family members.[20] As reported in Table 2, somewhat more than one quarter of plots are obtained through commercial transactions, either fixed rent or sharecropping contracts. These plots are left fallowed for almost eight months longer than are other plots farmed by the same cultivator.[21] Plots obtained from one's spouse may be left fallow less than other other plots, but the difference is not statistically significant at conventional levels. Plots that are obtained from other close family members are fallowed for almost ten months longer than are plots obtained from individuals who are not related.

There is important variation in fallow durations across the plots cultivated by a given individual, depending upon the provenance of the plot. This variation corresponds to the confidence that individuals express regarding their rights in focus group discussions, in which it was argued that commercial transactions or close family ties help to secure one's ability to re-establish cultivation on a fallowed plot, while women expressed particular concern over their ability to maintain control over plots obtained indirectly from other source via their spouse. Where relevant, these results also correspond to cultivators self-assessed rights over plots. Farmers claim the right to rent out land obtained from family on 39% of such plots, but only claim this right on 3% of plots obtained from non-family, and only on 1% of plots obtained from their spouse. Similar patterns are observed for the right to lend out the plot, sell it, or decide who will inherit it.[22]

We saw in column 1 of Table 7 that, conditional on household fixed effects, office holders fallow matrilineage land for much longer than they do land from outside the matrilineage. This accords with the literature on land rights in southern Ghana, which makes it clear that tenure

[20] The sample size is smaller in column 2 than in columns 1 or 3 because we are missing data on the identity of the individual from whom the plot was obtained for some plots.

[21] We find no significant differences in fallowing choices between sharecropped and fixed rent contracts.

[22] No farmer cultivating a plot commercially claims the right to rent it or lend it out, sell it, or decide who will inherit it.

security is not an attribute of an individual. Rather, an individual's security of tenure over a particular plot reflects that individuals' position within the local social and political hierarchy *and* the manner in which that plot was obtained.

Looking only across plots cultivated by a given individual, in column 3 of Table 7 we show that office holders fallow land from within their own *abusua* for almost two years longer than they do other plots that they cultivate. Because office holders are in a superior political position, they are more confident of their ability to reestablish cultivation on fallowed plots that they have obtained through the matrilineage allocation process, and therefore leave such plots fallow for longer.

We expect the increased security of plots cultivated by office holders to be particularly evident on plots that were obtained via this political process. Therefore, we restrict attention in the specification reported in column 4 to plots that were not obtained through commercial transactions. Office holders fallow noncommercial land from within their own *abusua* for almost 5 years longer than they do noncommercial land from other sources; in stark contrast, non-officeholders fallow noncommercial land from within their own *abusua* even less than they do land from other sources.

Office holders leave land fallow for longer periods than do other individuals within these villages. However, this is not simply a matter of office holders having a superior political and social position than other individuals and thus having more tenure security in general. Instead, their political power is exercised within specific contexts. Office holders are able to use their social and political status to secure their rights over plots that they obtain through the explicitly political process of land allocation through the matrilineage. However, this ability does not spill over into improved security of tenure in other contexts. We focus our attention, therefore, on the allocation of land within the matrilineage.

7 Land Allocation in the Matrilineage

A great deal of potential output is lost in the study area because land tenure is insecure. Pande and Udry (2005) provide a summary of the historical origins of the institution in which land use rights are allocated through the matrilineage. They show that this institution emerged during a long period of land abundance, during which fallow periods on virtually all land were sufficiently long for full restoration of land fertility. Tenure insecurity would have no consequence for fallow durations under such conditions. However, over the past several decades land has become more scarce, and therefore individuals' uncertainty regarding their ability to reestablish cultivation after a period of fallow now has implications for fallow durations and hence productivity. We do not adhere to a view that institutions necessarily adjust to capture all potential Pareto gains. However, the persistence of this method of land allocation in the face of the losses of output associated with tenure insecurity requires investigation.

In this section we examine the local political economy under which this land tenure regime exists, and the role that this land tenure system serves beyond its effect on investment incentives. Our interpretation has been strongly influenced by the expressed views of farmers in the survey villages. With preliminary evidence in hand regarding variations in fallowing behavior and its influence on farm profits, we conducted a sequence of seven focus group discussions in the four sample village clusters.[23] Few in the focus groups were surprised by our general findings, and a consensus quickly emerged in each of the groups that the primary cause of our finding is uncertainty over land tenure, particularly for women, and particularly for those not well-connected to chiefs and family heads.

Interestingly, the mechanism that was emphasized was not a fear of investing in future land fertility on plots over which future rights were uncertain, but rather a fear that the very act of investment (that is, leaving the land fallow) would weaken future rights over the plot.[24] The rhetoric surrounding the allocation of land through the *abusua* focuses primarily on "need". As described in section 2, any member of the *abusua* who needs land is entitled to some for cultivation. The determination of "need", not surprisingly, is often ambiguous. In our focus group discussions, the claim was made several times that the act of leaving a plot fallow would demonstrate a lack of sufficient need, and therefore cast doubt on one's right to the plot.

The central rationale for the allocation of land use rights via membership in the matrilineage

[23] These focus groups consisted of five to a dozen voluntary participants, drawn from both survey respondents and non-respondents. Most groups were single-gender, but others were mixed.

[24] This principle was best stated by a female participant in one of the focus groups: "Se me gya asaase no to ho̱ sɛ enyin a obi bɛba abɛfa; efisɛ ɛyɛ mekunu asaase." That is, "if I leave the land fallow then those who gave the land to my husband will think we don't need it and take it."

is redistribution. Limited access to credit markets remains pervasive in rural Ghana, and so land redistribution is seen as essential to preventing long term poverty. We suggest that differences in fallowing behavior are generated by the fact that the allocation of land through the matrilineage is aimed towards redistributing land to those most in need, but that need is private information, and that the extent of one's need can be signalled by choices with respect to fallowing.

The leadership of the matrilineage is unlikely to have complete information regarding the incomes of matrilineage members. Most adults in rural Ghana engage in nonfarm activities to complement their income from agriculture. In our sample, 65 percent of adults, and almost 80 percent of women earn some of their income from nonfarm activities. Small-scale trading is the dominant such activity. Information regarding the income that is generated from nonfarm activities is closely-held; even spouses are quite unlikely to know the details of one's incomes and expenditures from nonfarm enterprises (Goldstein 2000, chapter 1).

The matrilineage leadership has a responsibility to prevent members of the matrilineage from falling into extreme poverty. Chieftaincy disputes, and disputes between villagers and abusua leaders, often center around perceived misallocation of *abusua* land by the leadership (Berry 2001, chapter 2; Benneh, 1988). Failure by the leadership to allocate land to a sufficiently high proportion of the poor exposes the leaders to political penalties in the future.[25]

We now examine a model of the connection between tenure insecurity and investment in land quality that is consistent with these focus group discussions, with the literature on land tenure and the political organization of matrilineages, and with our econometric evidence. The *abusua* leadership is assumed to have an obligation to allocate (without charge) land to members of the *abusua* who have high need for that land; in our model, this will be those individuals who have particularly low return off-farm opportunities. These individuals are labeled 'poor'. Failure by the leadership to allocate land to a sufficiently high proportion of the poor exposes the leaders to political penalties in the future. The leadership, however, does not know who is poor and who is rich. Since the leaders have alternative uses for the *abusua* land, their problem is to allocate land to as many of the poor as possible, while keeping it out of the hands

[25] Fafchamps (1992) has a useful discussion of the reasons that informal redistribution in Africa often takes the form of land redistribution, rather than transfers of income. Moral hazard in cultivation makes transfers of income inefficient; by transferring land (and thus making the cultivator the residual claimant) helps mitigate this problem.

of the rich. We hypothesize that the leadership uses a cultivation requirement to construct an incentive-compatible mechanism that separates (most of) the poor from (most of) the rich. The leadership offers land to those who will cultivate it without leaving it fallow. The rich are generally unwilling to accept this contract: the sacrifice of their high nonfarm income would outweigh the benefit of cultivating poorly-fallowed land. The poor, however, find the trade-off worthwhile and accept the land.

We assume that each member of an *abusua* has an off-farm income opportunity, the return to which is private information to the individual. There are two classes, rich and poor, indexed by $k \in \{r, p\}$. Individual i in class k has returns to this non-farm activity denoted by $w_{ik} = w_k$, where $w_r > w_p > 1$. The model has two periods (each should be considered to last approximately 2 years, given the patterns of cultivation discussed in section 3). Individuals are risk neutral and do not discount the future. Each individual has an endowment of T units of time in each period. If an individual of class k does not cultivate any land from the *abusua*, her income will be $2Tw_{ik}$.

In addition to this nonfarm income, each individual i might be allocated a plot of land of area 1 by the abusua leadership. Let $c_{ik} \in [0, 1]$ be the time that i spends cultivating the plot in the first period, and choose units such that c_{ik} is also the amount of land that is cultivated in that c_{ik} units of time. Thus $(1 - c_{ik})$ of the plot is left fallow. Any land cultivated each year has a yield of 1 in each year; land left fallow by individual i this year yields $y_{ik} \geq 2$ next year, so fallowing is productively efficient.

y_{ik} is a random variable with a continuous probability density function $h(y)$ on its support of $[2, \bar{y}]$ that reflects the return to cultivating fallowed land by farmer i. This might reflect her access to complementary inputs, such as the particular types of labor required for clearing and cultivating fallowed land, or her commercial opportunities for sale of the output, or (since y_{ik} is disproportionately accrued during the second period) her access to credit. It is clear that random variation in the returns to cultivating non-fallowed land would not affect the argument that follows, as long is this is not perfectly correlated with the returns to cultivating fallowed land.

If given a plot of land, the individual's income over the two periods is

$$w_{ik}(T - c_{ik}) + c_{ik} + (1 - c_{ik})y_{ik} + (T - (1 - c_{ik}))w_{ik}. \tag{13}$$

The first two terms are the first period return: w_{ik} for the $(T - c_{ik})$ time spent not cultivating, and 1 for the c_{ik} time spent cultivating. The second two terms are the second period return: y_{ik} for the time spent cultivating the $(1 - c_{ik})$ land that was left fallow in the first period, and w_{ik} for the time spent not cultivating (any land that had been cultivated in period 1 is not worth cultivating in the second period, since $w_{ik} > 1$). Left to his own devices, the individual would choose to fallow his plot in the first period ($c_{ik} = 0$ since $y_{ik} > 2$). However, as suggested above, the *abusua* leadership may have reason to require $c_{ik} > 0$.

For fixed c, i accepts the *abusua* land if and only if

$$w_{ik} < c + (1 - c)y_{ik} \equiv \omega_{ik}(c) \tag{14}$$

$\omega_{ik}(c)$ is a continuous random variable as well, with support $[2 - c, c + (1 - c)\bar{y}]$ and distribution function $F(\omega; c)$[26]. Given an offer of one unit of land, with the requirement that c of that land be cultivated the first period, then the fraction $1 - F(w_p; c)$ of the poor individuals accept the offer, while $1 - F(w_r; c)$ of the rich accept, with $F(w_p; c) < F(w_r; c)$ since $w_p < w_r$, as shown in Figure 3. It will also be useful to note that $\frac{\partial F(\omega;c)}{\partial c} > 0$ for all $\omega \in (2 - c, c + (1 - c)\bar{y})$ (since the RHS of (14) is decreasing in c). An increase in the cultivation requirement increases the proportion of individuals who would reject an offer of land subject to the cultivation requirement.

There exist distributions of y such that there are choices of c with $F(w_p; c) = 0 < F(w_r; c) = 1$. For such distributions, c can be chosen such that all of the poor and none of the rich accept *abusua* land with the cultivation requirement c. As an extreme example, suppose $h(y) > 0$ only for $y = \hat{y} > 2$. In this case, setting

$$c = \frac{\hat{y} - w_p}{\hat{y} - 1} < 1 \tag{15}$$

suffices to induce all of the poor, and none of the rich to accept the land. We will consider distributions of y such that no such c exists. For example, $y \sim U[2, \bar{y}]$ ensures that for any c, at least some poor do not accept land, or at least some rich do.

Now consider the decisions of the *abusua* leader. He has M units of land that he can allocate. He has an obligation to allocate a unit of land to each poor farmer – this is the core social contract. If he fails to allocate land to the poor, he faces a possible penalty that we'll

[26] The probability density function of $\omega_{ik}(c)$ is $g(w; c) = \frac{1}{1-c} f(\frac{\omega - c}{1-c})$, where it will be recalled that $f()$ is the probability density function of y.

call P, which reflects the litigation costs of defending himself in a chieftaincy dispute, or the cost he has to pay in terms of distributing gifts and favors to the *abusua* elders to induce them to ignore the complaints of the poor who are justly angry at not receiving land. His problem is that he can observe neither the off-farm earnings, nor the y_{ik} realization of the members of the *abusua*. If he offers land with no conditions, of course the entire population will accept the land. Hence, he will use a cultivation requirement c in an attempt to screen out rich members, while still getting land to the poor.

The probability that he must face the penalty is increasing in the fraction of the poor population that did not receive land: $\pi(F(w_p; c))$, with $\pi' > 0$. The leader also benefits from the use of whatever land he doesn't allocate. If there is a measure of 1 unit each of poor and rich *abusua* members, then given cultivation requirement c, the *abusua* leader is left to cultivate

$$M - (1 - F(w_p; c)) - (1 - F(w_r; c)) \equiv M_L(c). \tag{16}$$

The leader's return to cultivating fallowed land is $G(M_L(c))$, which with incomplete factor markets, we assume is increasing but strictly concave. Since $\frac{\partial F(\omega;c)}{\partial c} > 0$, we have $\frac{dM_L}{dc} > 0$.

The leader's problem is to choose c to

$$\max_c G(M_L(c)) - \pi(F(w_p; c))P \tag{17}$$

The trade-off is clear: increases in c increase the amount of land available for the leader to cultivate. But they also increase the number of the poor who are not allocated land, and hence the probability that the leader will be penalized. At the optimal c^* we have

$$\left[\frac{dF(w_p; c^*)}{dc} + \frac{dF(w_r; c^*)}{dc}\right] G'(M_L(c^*)) = \pi'(F(w_p; c^*))\frac{dF(w_p; c^*)}{dc}P, \tag{18}$$

so that the benefits to the leadership of increasing the amount of land it cultivates by increasing c (on the LHS of 18) balance the costs of such increases in terms of the likelihood of facing penalty P.

This model of land allocation has features that correspond well to both the informal accounts of tenure insecurity that we received from cultivators themselves, and to patterns of investment behavior that are evident in our data. In column 1 of Table 8, we show that individuals who talk frequently (at least twice a week) with office holders have fallowing behavior that is essentially indistinguishable from office holders themselves. This is consistent with the idea of a cultivation requirement that is imposed as a way of distinguishing the poor from the rich among those about whom the officeholders have incomplete information. Officeholders have better information regarding the resources of those with whom they interact sufficiently intensively, and hence need not impose this costly revelation device. This result is also consistent with officeholders sharing rents with their friends.

In columns 2 and 3 we examine an important comparative static consequence of this model. From 18,

$$\frac{dc^*}{dM} = -\frac{G''(M_L(c^*))\left[\frac{dF(w_p;c^*)}{dc} + \frac{dF(w_r;c^*)}{dc}\right]}{D} < 0.^{27} \tag{19}$$

As matrilineage resources become more scarce, the leadership imposes stricter cultivation requirements (since the marginal value of additional land kept under their own control rises, they are more willing to risk the penalty associated with failure to allocate land to some of the poor). Therefore, the model implies that the gap between the fallow durations of non-office holders and office holders is larger in matrilineages in which land is more scarce.

In column 2 of Table 8, we see (unsurprisingly) that fallow durations are, in general, shorter in more densely-populated matrilineages. More importantly, in column 3, we observe that the difference in fallowing by office holders and others rises with population density in the matrilineage. The interquartile range of the number of households in an *abusua* per hectare of controlled by the *abusua* is approximately 1.5. These estimates imply that officeholders in a 'land scarce' matrilineage (at the 75th percentile of households/hectare) have a fallow duration about 5 years longer (relative to other households in that matrilineage) than households in a 'land

[27] where

$$\begin{aligned} D &= G''(M_L(c))\frac{dT_L}{dc}\left[\frac{dF_c(w_p)}{dc} + \frac{dF_c(w_r)}{dc}\right] \\ &\quad + G'(M_L(c))\left[\frac{d^2F_c(w_p)}{dc^2} + \frac{d^2F_c(w_r)}{dc^2}\right] \\ &\quad - P\pi''(F_c(w_p))\left(\frac{dF_c(w_p)}{dc}\right)^2 \\ &\quad - P\pi'(F_c(w_p))\frac{d^2F_c(w_p)}{dc^2} \\ &< 0. \end{aligned}$$

rich' matrilineage at the 25th percentile of households/hectare. The cultivation requirement imposed on non-office holders in exchange for receiving land is more strict in more densely populated matrilineages.

8 Conclusion

Our results provide support for the argument that in West Africa "the process of acquiring and defending rights in land is inherently a political process based on power relations among members of the social group.... A person's status ... can and often does determine his or her capacity to engage in tenure building" (Bassett and Crummey 1993, p. 20). Rights over a particular plot of land are political: they depend on the farmer's ability to mobilize support for her right over that particular plot. Hence the security of tenure is highly dependent upon the individual's position in relevant political and social hierarchies. Even conditional on the individual's position, her security depends upon the circumstances through which she came to obtain access to the particular plot.

The flexible system of allocating temporary usufruct rights through a political process at the matrilineage level has served a key reallocative purpose: helping avoid the emergence of a class of destitute landless in the villages. Similar processes of land reallocation through corporate groups exist in most societies in West Africa; as a consequence, the region is distinguished by the almost complete absence of a rural landless class.

The lack of success of widespread land titling programs in Africa has led many to question the conventional wisdom regarding the importance of secure property rights for investment in land. Bassett (p. 4) notes that "colonial administrators, African elites, and foreign aid donors have historically viewed indigenous landholding systems as obstacles to increasing agricultural output. ... There is a need to transcend [the World Bank's] technocratic and theological approaches that posit a direct link between freehold tenure and productivity." Based on her rich understanding of Akan land tenure, Berry (2001, pp. 155-56) argues that "contrary to recent literature, which argues that sustainable development will not take place unless rights to valuable resources are 'clearly defined, complete, enforced and transferable', assets and relationships in Kumawu appear to be flexible and resilient because they are *not* clearly defined, or completely and unambiguously transferable."

However, we find that the complex, multiple and overlapping rights to land in Akwapim *are* associated with barriers to investment in land fertility. Individuals who are not central in the networks of social and political power that permeate these villages cannot be confident of maintaining their rights over land while it is fallow. Hence, they fallow their land less than would be technically optimal, and farm productivity for these individuals is correspondingly reduced. There is a strong gender dimension to this pattern, because women are rarely in positions of sufficient political power to be confident of their rights to land. So women fallow their plots less than their husbands, and achieve much lower yields.

We interpret the resilience of this system of land tenure to its crucial role in redistributing resources in the face of unobserved variations in need. Households signal their low non-farm income by being willing to cultivate land that is fallowed only briefly; matrilineage leaders and those close to them have no need to resort to such costly signals. Therefore, there is a large gap in the fallow durations of officeholders and others in the village. We find that the efficiency cost of this system of insurance is increasing with population density in the matrilineage. As population density continues to increase, we might find that individuals and matrilineage leaders find ways to mitigate the costs associated with this system of land tenure. Udry and Pande (2005) present some evidence that individuals devote a higher share of their time to non-farm activities in more densely populated matrilineages, and that commercial land transactions are more common in those matrilineages. However, the long-term panel data from West Africa that would permit us to explore the dynamics of contractual arrangements as land becomes more scarce are currently not available.

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Table 1: Perceptions of Land Rights

	Percent of Cultivated Plots on which Respondent Claims Right to:				Percent of Plots Fallowed more than Six Years
	Determine Inheritance	Rent Out	Lend Out	Sell	
	(1)	(2)	(3)	(4)	(5)
Non-office holders	6	22	32	15	13
Office holders	26	53	60	32	22
t-test for equality	6.41	6.74	5.83	4.34	2.14
Number of observations	575	576	576	575	406

Table 2: Summary Statistics

Plot Level Data

Variable	Office Holders Mean	Office Holders Std. Dev.	Non-Office Holders Mean	Non-Office Holders Std. Dev.	|t|
profit x1000 cedis/hect	654.07	2434.05	538.22	6856.15	0.18
yield x1000 cedis/hect	1495.29	2903.87	1571.48	7345.97	0.11
hectares	0.48	0.62	0.31	0.30	4.26
labor cost x1000 cedis/hect	651.39	1155.59	883.14	2223.01	1.11
seed cost x1000 cedis/hect	282.12	612.24	243.08	719.98	0.45
ph	6.36	0.71	6.34	0.75	0.22
organic matter	3.22	1.06	3.13	1.08	0.67
last fallow duration (years)	4.83	4.23	3.93	2.65	2.60
length of tenure (years)	16.14	16.10	7.32	9.47	7.26
plot same abusua as individual	0.66	0.47	0.56	0.50	1.79
plot obtained via commercial transaction	0.25	0.43	0.30	0.46	1.17
n	122		484		

Individual Level Data

Variable	Office Holders Mean	Office Holders Std. Dev.	Non-Office Holders Mean	Non-Office Holders Std. Dev.	|t|
gender (1=female)	0.11	0.32	0.40	0.49	3.73
age	51.92	13.47	40.08	12.21	5.41
average assets x1000 cedis	1475.52	1767.18	620.39	902.57	4.71
years of schooling	7.56	6.98	7.09	4.92	0.50
1 if mother was a trader	0.09	0.29	0.24	0.43	2.23
1 if mother was a farmer	0.89	0.32	0.72	0.45	2.35
1 if father was a farmer	0.82	0.39	0.79	0.41	0.46
1 if father was an artisan	0.07	0.25	0.11	0.31	0.76
1 if father was a civil servant	0.09	0.29	0.09	0.29	0.02
1 if father was a laborer	0.00	0.00	0.00	0.07	0.46
1 if first in village of family	0.11	0.32	0.23	0.42	1.82
yrs family or resp has been in village	64.80	41.63	53.50	39.44	1.72
number of wives of father	2.82	1.71	2.14	1.20	3.18
number of children of father	12.04	7.32	10.84	6.51	1.10
parity of mother in father's wives	1.71	1.47	1.30	0.64	2.94
1 if fostered as a child	0.58	0.50	0.69	0.46	1.46
size of inherited land	0.62	0.83	0.13	0.39	6.10
1 if mother had any school	0.04	0.21	0.12	0.32	1.43
1 if father had any school	0.16	0.37	0.31	0.46	2.09
n	45		207		

notes: During the survey period, approximately 2200 cedis were equivilent to US $1.

Table 3: Profits and Gender

	1		2		3	
	OLS		OLS		OLS	
dependent variable	profit x1000 cedis/hect		profit x1000 cedis/hect		profit x1000 cedis/hect	
	estimate	std error	estimate	std error	estimate	std error
gender: 1=woman	-859	296	-1043	300	-1667	374
Plot Size Decile = 2	-572	200	447	179	1002	244
Plot Size Decile = 3	268	220	1039	295	475	267
Plot Size Decile = 4	-155	407	1135	302	788	298
Plot Size Decile = 5	-412	220	657	134	578	128
Plot Size Decile = 6	-495	290	811	163	97	210
Plot Size Decile = 7	-537	277	875	172	220	249
Plot Size Decile = 8	-616	327	439	302	-374	274
Plot Size Decile = 9	-474	246	249	284	-120	251
Plot Size Decile = 10	-900	283	-316	332	-1195	339
Soil Type = Loam	303	297	-175	211	-442	160
Soil Type = Clay	-199	105	-512	294	-525	324
Toposequence: midslope	-172	171	299	334	-468	389
Toposequence: bottom	19	172	663	337	-525	435
Toposequence: steep	-425	200	3	365	971	577
pH			-260	89	155	43
Organic Matter			-16	52	-347	76
Observations	782		508		508	
Fixed effects	household x year		household x year		spatial (250 meters) and household x year	

Standard errors are consistent for arbitrary heteroskedasticity and spatial correlation.

Table 4: Profits and Fallow Duration

	1		2		3		4		5	
	IV		OLS		IV		OLS		IV	
dependent variable	profit x1000 cedis/hect		fallow duration		profit x 1000		fallow duration		profit x 1000	
	estimate	std error	estimate	std error	estimate	std error	estimate	std error	estimate	std error
fallow duration (years)*	421	182			314	146			337	170
gender: 1=woman	19	433	-0.58	0.32	143	341	-0.43	0.26	316	418
age									10	22
> 6 years of school									88	439
1 if first of family in town			-0.44	0.47			0.29	0.20		
years family/resp lived in village			-0.01	0.01			0.01	0.00		
1 if resp holds trad. office			3.91	0.70			1.95	0.34		
number of wives of father			0.39	0.18			0.52	0.14		
number of father's children			-0.08	0.03			-0.02	0.02		
parity of mom in father's wives			-0.44	0.28			-0.42	0.31		
1 if fostered as child			0.86	0.25			0.35	0.33		
size of inherited land			-0.29	0.27			-0.52	0.20		
1 if mother had any education			-0.87	0.46			0.96	0.60		
1 if father had any education			-0.13	0.43			-0.98	0.35		
Observations	654		654		609		609		539	
Fixed Effects	Household x Year				Spatial (250 meters) and Household x Year				Spatial and Household x Year	
J-Stat of Over-ID Restrictions	Chi2(9) = 3.55				Chi2(9) = 2.15				Chi2(9) = 2.37	
F-test of instruments			F(10,627) = 7.80				F(10,572) = 20.27			

All regressions include household x year fixed effects and the plot characteristics used in Table 3.
Standard errors are consistent for arbitrary spatial correlation.

*Treated as endogenous. Instruments as indicated in columns 2&4.

Table 5: Nonlinear Estimates of Profits and Fallow Duration

	1		2		3	
	OLS		Nonlinear Least Squares		Nonlinear Least Squares	
Nonlinear component			Power function		Log function	
dependent variable	profit x1000 cedis/hect		profit x1000 cedis/hect		profit x1000 cedis/hect	
	estimate	std error	estimate	std error	estimate	std error
Fallow duration (years)	238	98				
Fallow duration squared	-4.30	4.90				
Nonlinear Parameters:						
a			-35132	7915	2982	887
b			37	9	-500	261

All regressions include household x year fixed effects and the plot characteristics used in Table 3.

Table 6: Fallow, Wealth and Land Owned

	1		2		3	
	IV		OLS		OLS	
dependent variable	fallow duration		wealth (x 1000 cedis)		fallow duration	
	estimate	std error	estimate	std error	estimate	std error
wealth (x 1000 cedis)*	-0.0001	0.001				
gender: 1=woman	-0.13	0.51	32	107	-0.27	0.23
area on other plots (ha)					-0.16	0.07
1 if first of family in town	0.04	0.62	145	89	0.22	0.28
years family/resp lived in village	0.01	0.01	8	1	0.01	0.00
1 if resp holds trad. office	2.01	0.97	497	174	2.01	0.36
number of wives of father	0.32	0.28	128	36	0.33	0.17
number of father's children	-0.02	0.07	-46	10	0.00	0.02
parity of mom in father's wives	-0.30	0.42	141	64	-0.40	0.34
1 if fostered as child	0.31	0.60	-152	86	0.38	0.34
size of inherited land	-0.44	0.64	-262	118	-0.33	0.23
1 if mother had any education	0.56	1.10	-318	239	0.67	0.52
1 if father had any education	-0.81	0.61	-84	91	-0.83	0.41
1 if mother was a farmer			-658	232		
1 if father was a farmer			357	111		
1 if father had an office job			696	168		
Observations	413		413		413	
Fixed Effects	Household and Spatial Fixed Effects (250 meters)					
J-Stat of Over-ID Restrictions	Chi2(2) = 1.40					
F-test of instruments			F(3,409) = 6.51			

All regressions include the plot characteristics used in Table 3.
Standard errors are consistent for arbitrary spatial correlation.

*Treated as endogenous. Instruments as indicated in column 2.

Table 7: Fallow Duration and Plot Origin

	1		2		3		4	
	OLS		OLS		OLS		OLS	
	All Plots		All Plots		All Plots		Exclude Commercial Plots	
dependent variable	fallow duration		fallow duration		fallow duration		fallow duration	
	estimate	std error	estimate	std error	estimate	std error	estimate	std error
gender: 1=woman	-0.28	0.22						
1 if office holder	0.68	0.59						
Plot in Same Abusua as Cultivator	0.25	0.21			-0.31	0.20	-1.10	0.37
Cultivator Holds Office * Plot in Same Abusua as Cultivator	3.24	0.89			2.16	0.88	5.96	2.16
Plot obtained Commercially			0.64	0.26				
Plot obtained from Spouse			-0.58	0.41				
Plot obtained from Family			0.83	0.36				
Observations	402		388		402		266	
Fixed Effects	Household and Spatial Fixed Effects		Individual Cultivator and Spatial Fixed Effects (250 meters)					

All regressions include the plot characteristics used in Table 3.
Standard errors are consistent for arbitrary spatial correlation.

Table 8: Fallowing, Networks and Matrilineage Resources

	1		2		3	
	OLS		OLS		OLS	
	All Plots		All Plots		Exclude Commercial Plots	
dependent variable	fallow duration		fallow duration		fallow duration	
	estimate	std error	estimate	std error	estimate	std error
Gender (1 = Women)	0.12	0.45	-0.66	0.35	-0.69	0.60
1 if Office Holder	2.67	0.45	3.88	0.63	-2.44	2.21
1 if talks with office holder at least twice weekly	2.05	0.53				
Households in Abusua /(Abusua Hectares)			-0.23	0.05	-0.63	0.58
Office Holder * Housholds in Abusua /(Abusua Hectares)					3.38	1.37
Observations	323		368		368	
Fixed Effects	Household and Spatial Fixed Effects (250 meters)					
Quintiles of Population Density	25%	50%	75%			
Households in Abusua/(Abusua hectares)	1.08	1.91	2.60			

All regressions include the plot characteristics used in Table 3.
Standard errors are consistent for arbitrary spatial correlation.

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Figure 1: Plots of Sample Members in One Village

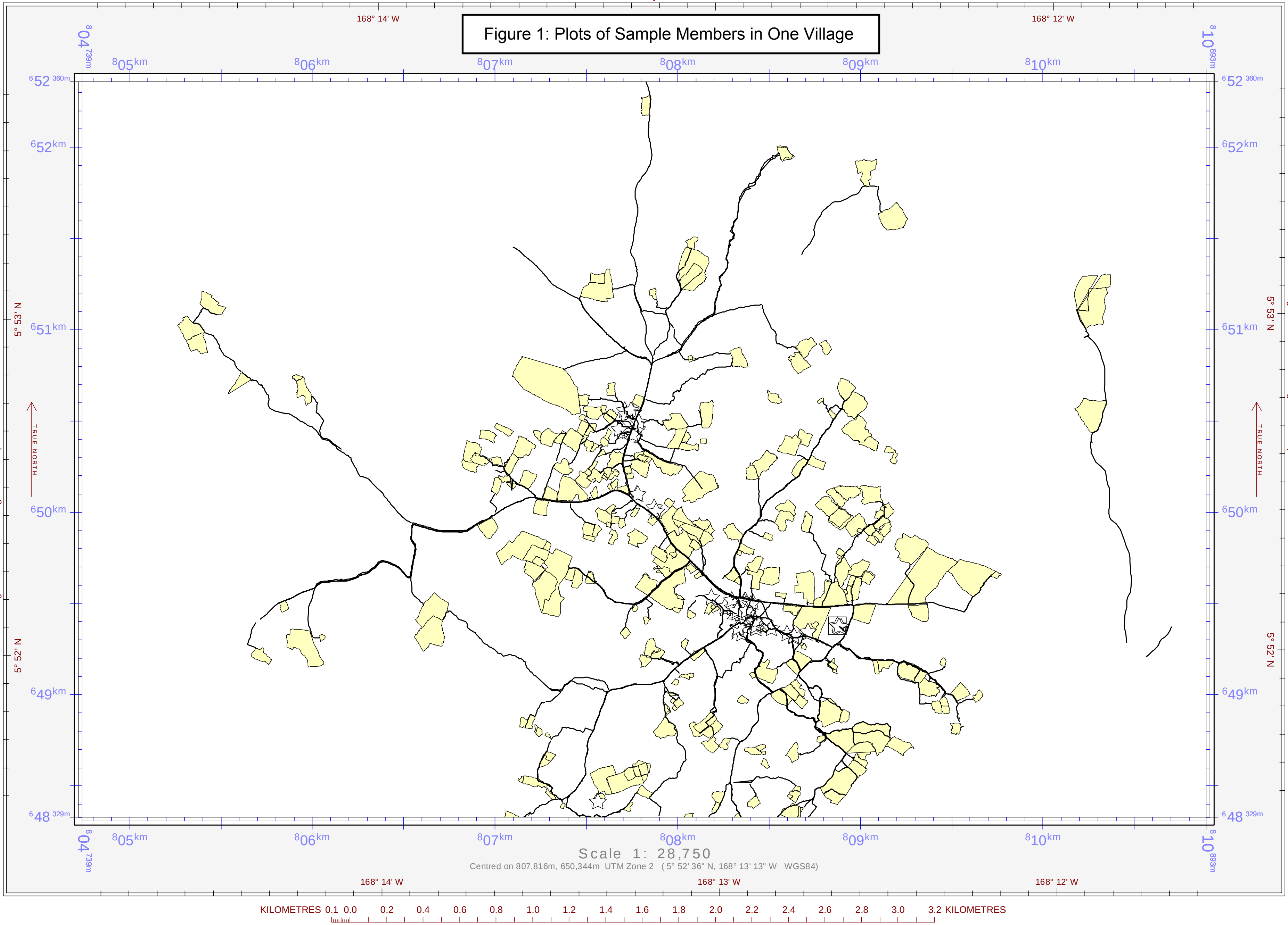
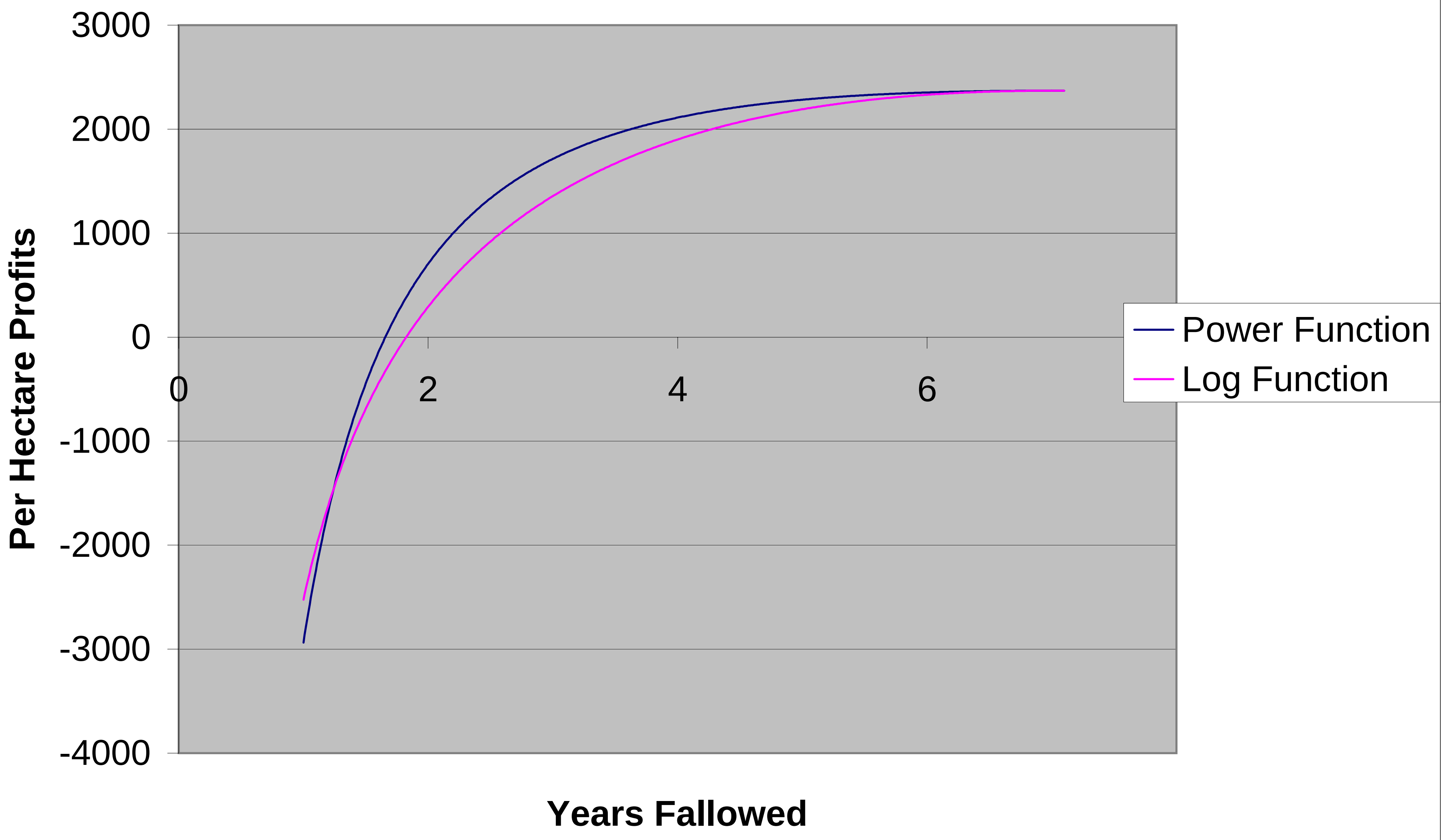


Figure 2: Fallow Duration and Profits



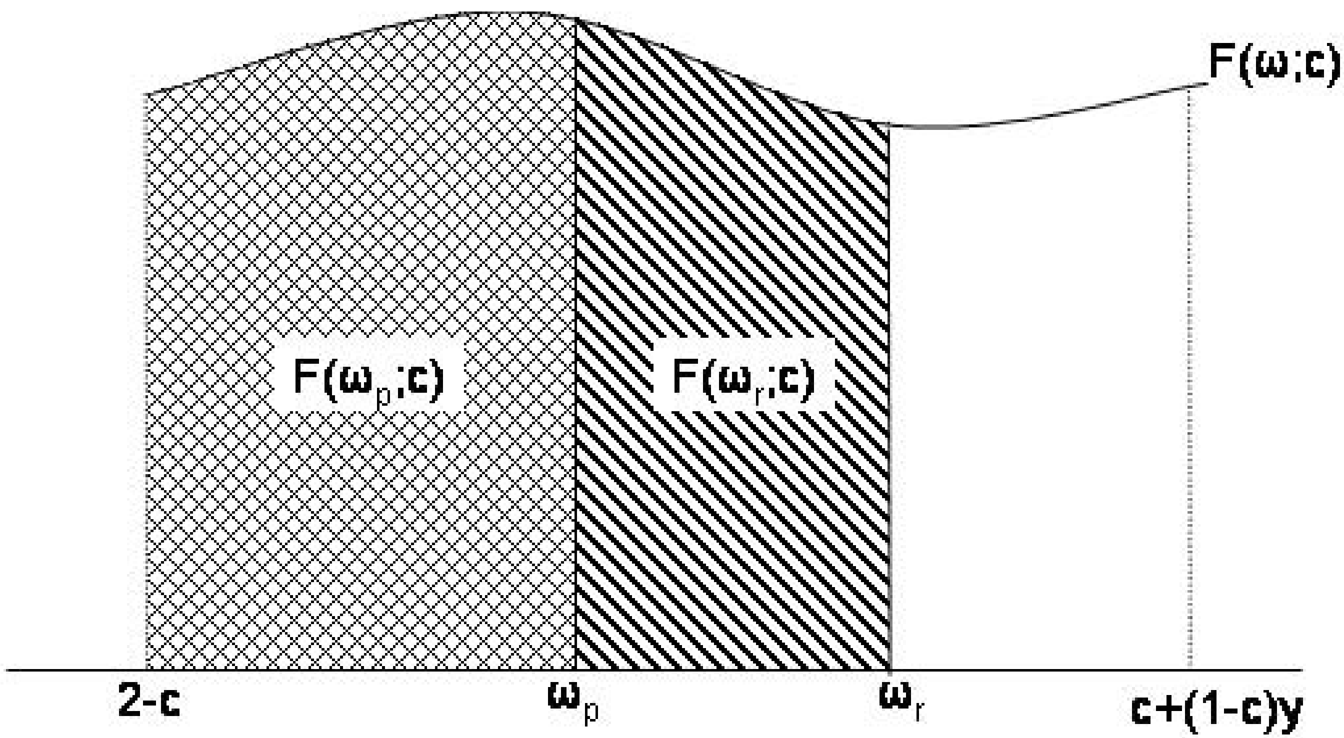


Figure 3: Proportion of rich and poor who reject *abusua* land