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Kimura, Yuichi

Faculty of Economics, Oita University

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Why are Overlapping Land Rights
Disincentive against Investment in Agriculture?:
Customary Land Tenure Institution in West Africa*

Yuichi Kimura

Oita University

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Address: 700 Dannoharu, Oita, Oita, 8701192 Japan.

E-mail: ykimura@oita-u.ac.jp. Phone: 81 97 554 6089.

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Abstract

Under customary land tenure systems in Ghana, lands obtained via matrilineal bonds exhibit a low inclination to invest in rubber, or input use and yield are low when investment in rubber is made in those lands. The land titling project and the rubber company's intervention in reconciling land tenure with the farmers' lineage groups do not have causal impacts on investments. The property rights thesis predicts that the overlapped and unclear land rights in those family-provided lands hold back investment incentives. However, empirical findings did not support the explanations based on the risk of future re-appropriation of land, re-distribution pressure on the output, labor shirk in the commonly managed lands, or a lack of lands' collateral function as the explanation for the investment gap in family-provided lands. Controversially, the low investment is more prominent when households have individualized land rights to perform within-household inheritance, which explains the most significant part of the low investment in family-provided lands. A particular inclination to avert investment risk must lie behind the low investment in customary lands.

1 Introduction

The issues of whether unclearly defined land rights under the customary land tenure system deter investment in farming and whether land tenure formalization improves incentives for land use intensification have been central to the land policy debates in Africa. The majority of subsistence farming villages operate under a customary land tenure system, under which individuals most often acquire access to land through negotiations among lineage members or inheritance within a matrilineal inheritance system. Norms about access to land and farming resources are not necessarily egalitarian (Berry 1993; Austin 2005). However, with its limited land transferability and customary norms, the system sustains a stable small holding structure and provides a minimum livelihood for the subsistence farm village population.

On the other hand, the cultivators' long-term access to land may be insecure under the customary land tenure system. The matrilineal inheritance system prevalent in West Africa provides that lands are inherited from a male cultivator to his nephew on the mother's side (sister's son) via a matrilineal kinship tie. It is a system that involves many individuals within the lineage group in the access to the lineage lands, which makes the access to the lands always subject to potential renegotiation by members of the lineage group, entangling the members in disputes on the rights to the land.

Perennial cash crops, such as cocoa, oil palm, or rubber, potentially contribute to substantial improvements in the income of farming households in low-income countries (Byerlee et al. 2008). The long-term security of land access is a prerequisite for decisions on investing in tree planting since these crops require substantial initial investments and years of maintenance before they begin to produce yields. An individual's ability to collect profits from investments in land can be undermined when land ownership is ambiguous. Therefore, it has been acknowledged that unclear and mutually overlapping land rights determined according to customary land tenure systems may hamper investment incentives and limit

opportunities to achieve poverty reduction (Bruce and Migot-Adholla 1994; Platteau 1995; Deininger 2003). This recognition is in line with the property rights institution argument in the seminal works of Coase (1937, 1960) and North (1981). Based on such a rationale, land tenure privatization is underway in various other places in sub-Saharan Africa.

Rubber contracting is a relatively new opportunity available to farmers in the western coastal region of Ghana, which is the area examined in this study. It gained prominence after the rubber plantation company established branches as it expanded its catchment areas calling for the participation of smallholder contractors. The company's extension offices and processing facilities provided access to new farming technologies, loans for purchasing agricultural inputs, and market channels. Given that the effect of land security depends on other conditions such as those listed above (Asaaga, Hirons, and Malhi 2020), the local settings that fulfill these conditions provide ideal circumstances for testing the potential impacts of land tenure security.

The first focus of the study is how loosely defined land rights of lands acquired through kinship ties affect investments in farming and how external interventions impact these decisions. Two types of interventions were examined. The first is a formal land registration project implemented in the study area. Pilot legal land tenure reforms were initiated across broad stretches of the country, including the villages examined in this study. The second type of intervention is an informal intervention by the rubber company aimed at reconciling land tenure agreements between its contractors with their lineage members in cases where there is a risk of conflict erupting over multiple claims to rights over the land.

The findings of different studies are inconsistent as to whether customary land tenure impedes long-term investment or whether perceived land rights are linked with the extent of intensity of land use. Many studies have found that perceived land rights have insignificant impacts on farm investments, and these results cast doubt on the necessity of land right formalization. It has been interpreted as indicating that customary land rights provide sufficient for securing incentives for investment or that titling projects should be directed

toward assisting the process of transition of customary systems rather than replacing them outright with a formal system (Place and Hazel 1993; Migot-Adholla, Place, and Oluoch-Kosura 1994, Migot-Adholla et al. 1994; Pinckney and Kimuyu 1994; Platteau 1995; Place and Migot-Adholla 1998; Brasselle, Gaspart, and Platteau 2002; Place 2009). Other studies have found that perceived land rights or the formalization of land rights significantly impact certain types of land investments in different parts of sub-Saharan Africa (Besley 1995; Deininger 2003; Deininger and Jin 2006; Abdulai, Owusu, and Goetz 2011; Fenske 2011; Ali, Deininger, and Goldstein 2014). Lambrecht and Asare (2015) surveyed different studies conducted in Ghana to find that results vary even within the same country.

Whether securer land tenure incentivizes investments entails theoretical ambiguity. Customary land institutions provide that once the current cultivator puts in effort and inputs in the land, usufruct rights are vested in that person and are maintained as long as the crop is growing over the land (Austin 2005). Under that condition, cultivators with weaker tenure may have greater motivation for investing in perennial crops in the expectation of enhanced future land security by demonstrating their usage rights. Since stronger land security can result in reverse ways from making a long-term investment, the overall impact of existing land tenure security on investment is indeterminate (Besley 1995; Otsuka et al. 2003; Deininger and Jin 2006; Ali et al. 2014).

The fundamental explanations as to why overlapping rights under customary land tenure system lowers farm investment, the arguments made in many studies in the literature implicitly assume the risk of re-appropriation of lands to be reallocated to other lineage members.

Another strand of studies points to the sharing pressure that accrues that impedes guaranteed access to or monopolizability of the returns to investment (Platteau 1996). The primary motive behind redistributive norms is to maintain mutual insurance as a safeguard against unexpected shocks and to keep oneself entitled to mutual insurance (Platteau 1991; Fafchamps 1992). In connection with sharing obligation, an economic success standing out in the local community can be subject to envy and moral punishment under egalitarian

norms (Platteau 2000; Di Falco and Bulte 2011; Di Falco et al. 2018).¹ It is an issue of mismatch between the beneficiary and cost bearing, where the cultivator bears the costs of investing in cash crops, but the consequent outputs may be subject to free-riding by multiple stakeholders in the lineage group. It can deter incentives for investment if we assume away people’s altruistic motives.

Guirkinger, Platteau, and Goetghebuer (2015) observe that the low management intensity of collectively owned lands results from limited labor inputs. Collectively managed lands, usually devoted to food crops managed by the entire household, are subject to moral hazard or free-riding problems where household members conserve their efforts to reserve for their own individually controlled plots.

From the perspective of credit access, lands with clearly defined ownership and mortgage rights acquire collateral value if a functioning local credit market exists (Feder et al. 1988; Feder and Feeny 1991). Loosely defined and overlapping land right claims can deter the provision of input loans because it undermines the collateral value of the lands by obscuring debt liability and posing a risk of credit loss on the loan provider.

The rest of the paper is organized as follows. Section 2 discusses the historical background of land tenure systems of West Africa and a brief review of the literature on land tenure systems. Section 3 presents the data, the spread of rubber cultivation, and the interventions in land tenure by the formal land titling process and by the rubber company. Section 4 presents the empirical results and interprets them to discuss what accounts for the low investment in customary tenure. Section 5 concludes.

2 Land Rights Institution

The matrilineal inheritance system emerged and persisted under abundant land and scarce labor. Customary practices provide incentives to clear the forest and prepare the ground for cultivation, as land rights are conferred to those who exert these efforts. The lands

appropriated in that way are held collectively by lineage groups, allocated for use by lineage members, and transferred to the next generation by matrilineal inheritance. Hypothetically, this system evolved for the advantage of attracting a large number of individuals for future reclamation of lands (Austin 2005).

Over the course of economic development, customary land tenure systems have been evolving towards more individualized land tenure systems in response to returns on investments in commercial crops and rising population pressure (Bruce and Migot-Adholla 1994; Amanor 2001; Otsuka et al. 2001, 2003; Quisumbing et al. 2001b; Place 2009; Holden and Otsuka 2014). The changes in factor endowment from a land-abundant and labor-scarce economy to one that is land-scarce and labor-abundant were associated with the migrants who settled in from the northern part of Ghana, Burkina Faso, Togo, and Côte d'Ivoire. The settlement of migrants increased during the expansion of cocoa cultivation in the 1920s, 1950s, and particularly in the late 1960s when cocoa cultivation expanded rapidly. With the increase of population pressure and the gradual emergence of land markets, the notable institutional change involved emergence of gift transfers, which is essentially an ordinary patrilineal inheritance. Gift transfers have gradually emerged since the issuance of the Intestate Succession Law in 1985, which aims to remedy the insecurity of wives' and siblings' land rights (Quisumbing et al. 2001a).

According to historical accounts from West Africa, weak tenure security is a product of legal pluralism, where the overlapping of the statutory land tenure system imposed by the colonial regime with the existing customary land tenure system (Amanor 2001; Crook 2008). The deterioration of customary rights has been apparent in some instances involving customary chiefs taking advantage of the confusion to sell community land for their benefit (Lavigne Delville 2000). Holden and Otsuka (2014) observed that the capture of land resources by the elite occurs where statutory law (or titling projects) fails to recognize or build on customary land tenure systems. Conversely, Quan, Ubink, and Antwi (2008) point to critiques about supporting by a formal institution of customary land relations that

involve inherently unequal power relations.

3 Data

Data were collected from four districts in the Western Region of Ghana. Eight villages were sampled from the four districts: two villages from the Ahanta West district, where Ghana Rubber Estates Limited (GREL) started a rubber company in 1962, three villages from Nzema East, three from Mpohor/Wassa East district, and one from Wassa West district. These four districts are the central catchment area where the company has been expanding its contract growers. Two villages, one in the Mpohor/Wassa East and the other in the Wassa West district, are located in the inland Western Region, where the spread of rubber cultivation is relatively new. The other six villages are located in the coastal areas of the same region where rubber cultivation occurred at the earliest in the country.

3.1 The Spread of Rubber Cultivation

The company started smallholder contracting in 1995, and by 2000, it had around 449 households registered as contract growers. This number increased to 1160 by 2005, 2832 by 2010, 5500 by 2013, and 7815 by 2015. The data for this study were sampled from these smallholder growers. The company initially started in the form of plantations in 1957 and expanded its plantation to 39 thousand hectares by 1962. The company switched from a plantation scheme to a smallholder contracting scheme (commonly known as the outgrower scheme) after 1995 for further expansion. Smallholder scheme allows farmers to enter production as they maintain their original land holdings, which does not involve any land transaction between the farmers and the company. Behind the change of schemes, there is recognition built among cash crop businesses that large-scale land acquisition associated with the establishment of plantations often leads to displacement and dispossession of land.

Summary statistics are shown in Table 1. The data include information from 228 house-

holds with a total of 541 farm plots collected from interviews with one respondent from each sampled household. The sample excludes recent migrants in 1995 and later who are likely to have moved in for rubber cultivation. The sampled households had an average of 2.4 farm plots with an average size of 2.9 hectares. The majority are Akans, for which matrilineal inheritance has been the traditional practice. Other non-Akan households are Muslims, among whom the ordinary patrilineal inheritance is common. Most main cultivators are males, and females account for 16%, including female-headed households.

[Table 1 Summary Statistics]

More than half of the sample plots were planted with rubber at the time of the survey. Figure 1 shows the number of adoption of rubber and other crops against the years when the cultivators started that crop. The three types of cash crops increase starting from the second half of the 1990s. Rubber cultivation spread rapidly, beginning in the same period. Once it begins to yield, the yield value per hectare of rubber is much more lucrative than other cash crops and food crops such as cassava and plantain. Roughly one-fourth of the sample plots received the company's intervention in tenure reconciliation, and half were title registered. Figure 2 shows when and how the respondent's families acquired the lands. Land acquisition was almost solely through an appropriation from the village (55% of the plots under current cultivation), dating from as early as the colonial period during the nineteenth century.

[Figure 1 Adoption of Rubber and Other Cash Crops]

[Figure 2 Year of Family's Land Acquisition by Acquisition Mode]

The transition over time of land acquisition modes of the current cultivators is shown in Figure 3. The composition of land transfer modes changed markedly after 1995 when rubber cultivation began to spread in the region. Allocation from the village is no longer

an essential means of obtaining land, replaced mainly by an allocation from lineage groups, inheritance, and renting. Cultivators' land tenure is prone to overlapping claims when lands are allocated via kinship ties, namely, by allocation and inheritance from matrilineal clans. Around half of the plots recorded in the data were obtained via these two modes.

[Figure 3 Year of Cultivator's Land Acquisition by Acquisition Mode]

3.2 Land Titling and the Rubber Company's Intervention

With the rising population pressure, scarcity of arable land, and the possibility of better income opportunities that became available by the entry of commercial crop companies into the region, investment incentives came to be accorded higher priority over customary tenure. These have been the main rationales behind the institutional reforms to formalize and individualize land tenure systems (Atwood 1990), which essentially are individualization and formalization of land rights broadly in line with neoliberal ideology (Amanor 2001; Pickery and Kimuyu 1994; Chimhowu 2019).

A deed registration system was initiated under the Land Title Registration Law of 1986 and started virtually after a second wave of land reform under the Land Administration Project (LAP) that followed the 1999 National Land Policy implementation. Implementation of phase 1 of this policy occurred from 2004 to 2010 and was intended to ensure enhanced personnel and logistical capacity (Kasanga and Kotey 2001; Cotula, Toulmin, and Hosse 2004). Under the new land registration system, farmers voluntarily register land at local offices of the Lands Commission. Titling and the issue of title deeds ensure the provision of exclusive land use rights to the right holder, guaranteeing the holder's rights when conflicts over contested land use rights are brought to court.

There has been concern that the commercialization of rural land institutions causes distress sales that lead to the concentration of landholdings within a small elite group and an increase in the landless poor. In the study site, customary law prohibits outright land

sales to outsiders, even after formal titling. Attempts to sell land, whether to outsiders or other villagers, must be preceded by consultations with the village chief and elders. As such inquiries are rejected in most cases because of the austerity of customary norms, land sales rarely occurred in the study site, unlike other studies such as Yamano et al. (2009) in Kenya and Ali et al. (2014) in Rwanda.

Apart from the legal land reform, Ghana Rubber Estates Limited (GREL) intervenes to assist prospective smallholder contractors through a land rights reconciliation process when their land use rights are prone to the risk of disputes or litigation. The company mediates the negotiation between the contractor and the stakeholders within the lineage group to confirm the contractor's long-term access to the plot. Interventions to reconcile land tenure occurred for 26% of the sample plots (43% of rubber plots). It should be noted that this intervention is provided on the prospect that the cultivator is potentially a rubber contractor. Almost all of the company's interventions (over 95%) resulted in rubber contracting. The company provides technical assistance in preparing the land and loans in kind for seedlings and fertilizer at the initial investment, along with access to the market channels through its operation of the processing facility in the area.

Table 2 shows the frequency of interventions applied by the types of crops adopted and by the gender of the main cultivators. The table shows that interventions to reconcile land tenure are exclusively provided for prospective rubber grower contractors. Likewise, titling is applied almost solely to rubber plots, suggesting that title registration is deeply linked with the spread of rubber cultivation. The proportions of reconciliation interventions involving men's and women's plots are balanced: 26% for both. The gender balance also holds for title registration: 42% and 46% for men and women, respectively. The rubber company is directly promoting women's participation as a part of its corporate social responsibility efforts. By encouraging women to register as contractors, the company aims to increase the share of female contractors to meet a target of 30% compared with the current 18%. The rate of adoption of rubber cultivation among women (54%) is comparable with that of

men (58%). The company's promotion of female contractors has contributed to women's participation in rubber cultivation.

[Table 2 Interventions in land tenure by crop and gender]

Table 3 shows how perceived land rights relate to titling and tenure reconciliation. It reveals seven types of land rights as perceived by men and women.² The numbers in parentheses indicate differences in perceived rights between the treated and untreated plots. The statistical significance of the differences in the perceived rights between treated and untreated groups is indicated by symbols attached to the parentheses. Tenure reconciliation is associated with a significantly higher rate of holding mortgage rights for both men and women. Reconciliation is related also to a higher rate of perceived rights to nominate an heir and to rent out for women. Land titling is associated with the right to give as gifts for both men and women, suggesting that titling enhances, or that titling decisions are affected by, individualized land rights.

[Table 3 Perceived rights and interventions in land tenure]

Table 4 shows how the land acquisition modes relate to access to these interventions. The numbers in parentheses indicate the differences between the percentages treated for the given acquisition mode to the percentage among all lands. Tenure reconciliation was less likely to be provided to cultivators of family-provided lands: those obtained via allocation or inheritance from the matrilineal clan. The same applies to titling, with purchased lands treated more often and inherited lands less often treated than average.

[Table 4 Mode of Land Acquisition and Interventions in Land Tenure]

4 Empirical Results

4.1 The Results

The results of tree planting decisions are shown in Table 5. The table shows only the coefficients of key variables.³ Lands inherited or allocated via the matrilineal lineage group are indicated as a family-provided dummy variable. Column 1 shows that rubber cultivation is less likely to be adopted in those by around 15 percentage points. However, there is a reason to suspect endogeneity of the family origin of lands if cultivators with weaker political status are more often allocated such lands (Udry 1996; Goldstein and Udry 2008). If that is the case, the negative coefficient of the family-provided lands might have resulted from the correlation of the weak political status with the family-origin status of the lands and, at the same time, with investment decisions.

[Table 5 Investment in Tree Planting]

The family origin of lands is instrumented using the distance to the farm plots from the residential area, in addition to other conditions that capture the political status of the cultivators, measured in variables used by Goldstein and Udry (2008). These variables are the village office holding status of the household head⁴, the number of wives of the cultivator's father, the wife order of the cultivator's mother that takes the value of one if the mother is the first wife of the cultivator's father, and the number of siblings of the father. The set of instruments fully meets the validity conditions. The results are shown in column 2. Instrumenting the family-provided dummy resulted in a smaller and statistically insignificant coefficient of family origin. At the same time, the exogeneity is not rejected by Wooldridge's robust score test with a safe margin. The test result suggests that the negative coefficient of the family-provided dummy is not a result of being affected by the unobserved differences in the negotiation power or selectivity in the process the lineage lands are allocated.

Column 3 examines the impact of land titling on the adoption of rubber. The OLS estimate shows a positive association between titling and the unit yield. A possible endogeneity of land titling is controlled for in column 4 using the same set of instrumental variables as used in column 2. The robust score test suggests that the exogeneity of land titling should be maintained. In columns 3 and 4, the negative coefficient of family-provided lands is not affected. Or it became slightly larger when land titling was included. Land titling does not remedy the disincentives in family-provided lands but rather slightly exacerbates the investment gap between family lands and those obtained from other channels.

The impact of the rubber company's tenure reconciliation is examined in columns 5 and 6. The OLS estimate indicates a positive association of the intervention with the investment, which turns insignificant when it is instrumented. The test result decisively rejects the exogeneity. The reconciliation is provided selectively for the prospective outgrower contractors, thus involving inverse causality. The negative coefficient of family-provided lands is unaffected by controlling for the reconciliation, suggesting that the reconciliation did not remedy the disincentives in those lands.

Table 6 shows the results of value per hectare. The OLS estimate in column 1 shows that family-provided lands exhibit a lower value per hectare. The magnitude of the perverse effect, -773 Ghana Cedis per hectare, amounts to around 50% decline from the sample mean of 1361. In column 2, an indicator of having received land titling is included. Titling is not found to augment productivity. In column 3, an indicator of having received the land tenure reconciliation is included. Tenure reconciliation is positively linked with productivity. The magnitude of the impact, 1118 Ghana Cedis is fairly large compared with the sample mean of 1361 Ghana Cedis. The unit yield of the group that received the reconciliation is almost double the group that did not.

[Table 6 Yield value per hectare and family lands, impact of interventions]

With the tenure reconciliation included, the coefficient of family origin of lands becomes

much smaller and statistically insignificant, suggesting that a sizable part of the negative association of family origin with low yield is due to inclination away from benefiting from the company's intervention. However, receiving the tenure reconciliation most of the time means that the cultivator takes part in the outgrower project, and that involves owing loan debt from the company for planting trees. Therefore, the access to the intervention can be endogenous, reflecting inherently strong land right that makes taking the risk of loan uptake permissible. As seen in column 4, family origin indeed lowers the inclination to benefit from tenure reconciliation. As this intervention augments productivity, the family origin of lands lowers productivity by lowering the chances that the cultivators benefit from it.

The endogeneity of receiving tenure reconciliation is controlled for in Column 5, using the same set of instrumental variables as in Table 5. The instrumental variables predict the tenure reconciliation with a sufficiently high significance level and fulfill the exclusion restrictions. The coefficient of tenure reconciliation turns statistically insignificant when it is instrumented. However, standard falsification tests do not reject the exogeneity of the instruments with a very safe margin. Tenure reconciliation is, therefore, treated as exogenous in what follows.

An important question remains whether the tenure reconciliation has improved the weak tenure of family-provided lands. Column 6 shows the estimates with an interaction term of the family-provided dummy and the tenure reconciliation dummy is included. The coefficient of the interaction term is statistically significant, and including it makes the productivity gap in family lands statistically slightly insignificant. However, the size of the coefficient does not change. It is controversial that the intervention benefited family-provided lands to a larger extent, but the productivity gap did not close. As discussed in Table 7, it could be consistently understood by an inclination away from the intervention for family-provided lands and a selection into the intervention for those holding mortgage rights.

Table 7 looks at the impacts of perceived land rights on the yield value per parcel. Over 100 land plots obtained through renting are excluded from the sample to avoid it to affect the estimates of the effect of land rights. Those lands are usually vested with the rights to plant trees and cultivate but far less often with the rights to transfer or to mortgage.⁵ The table shows coefficients of family-provided lands and land rights. All other control variables are included in the estimation.

[Table 7 Impacts of perceived rights on yield value per hectare]

In column 1, the gap between the family-provided and other lands, 1419 Ghana Cedis, is larger than in Table 6 because the rented lands are excluded from the base group. The magnitude of the negative impacts of family origin of lands now approaches the sample mean of 1808 Ghana Cedis. Six categories of land rights are added in column 2. The right to give as a gift, which is the right to inherit to children or wives without the involvement of lineage members, is negatively, and the mortgage right is positively related to the unit yield. The negative coefficient of family origin declines by half when land rights are controlled for, suggesting that the differences in those land rights explain a sizable portion of the disincentives against investment in family-provided lands.

There are reasons to suspect endogeneity of mortgage rights and gift rights because investments made might have augmented those rights. Although the mortgage right from planting trees usually pertains to “the trees growing on the plot” (Berry 1993), the rights on the land may still be augmented. In column 3, results are presented with those two categories of land rights instrumented using the same instrumental variables as in table 6. Instrumented estimate of gift rights is larger and stays significant, and the coefficient of mortgage rights becomes larger while it turns statistically slightly insignificant.

The impact of tenure reconciliation is shown in column 4. The reconciliation intervention is found to augment the yield statistically significantly and controlling for it makes the coefficient of the family-provided dummy decline by half. Column 5 and 6 show how the de-

cisions to take up the reconciliation depends on differences in the land rights. Lands' family origin is negatively related to access to the intervention, as seen in column 4 of Table 6. Among the perceived land rights, the right to plant trees is negatively related to the reception of the intervention, suggesting that cultivators without tree planting rights are treated according to their needs. Mortgage right is positively related to the intervention. The effect of mortgage rights can be endogenous if the right has been strengthened due to receiving the intervention. Nevertheless, the concern is dismissed as the effect of mortgage rights remains statistically significant after being instrumented in column 6. Therefore, Mortgage rights indirectly enhance the unit yield by enhancing benefiting from the intervention (columns 5 and 6), then via the impact of tenure reconciliation (column 4).

Column 7 includes tenure reconciliation with the gift right and mortgage right controlled for. In the same way as column 2, the two types of land rights are linked negatively and positively with the unit yield, respectively. The effect of tenure reconciliation turns statistically insignificant when these land rights are controlled for. It suggests that the impact of intervention emerged via the selection into access to the intervention by those rights. That is, the impact of the intervention is not its own effect. The instrumental variable estimate shown in column 8 controls for possible endogeneity of the rights variables and finds their exogeneity safely away from rejection. It confirms the interpretation of column 7: the dependence of the intervention on the inherent land rights rather than vice versa.

The reason why gift right is negatively related to yield is controversial. Hypothetically, when households have individualized land rights and can inherit to children, they avoid devoting that land to cash crops, which involve debt obligation. This will be examined further by looking at input use decisions and access to loans. Overall, the results of Table 7 support that the collateral function of lands augments the yield both directly and indirectly by benefiting from intervention. The collateral view, from the results so far, seems to account for the large investment and productivity lag in the family-provided lands, but this

will be further examined in Tables 9 and 10.

Table 8 examines how household size, lineage group size, and family labor or those employed from lineage groups affect the productivity of rubber plots. It reveals an interesting insight into how different possible hypotheses: land re-appropriation risk, the re-distributive obligation of output, and labor-shirk account for the low yield in family-provided lands. Labor input is measured in wage expenditure per hectare of rubber plots. After wage expenditure is included in the yield per hectare equation, the negative impact of family origin of lands is 1443 Ghana Cedis, around -80% of the sample mean of 1808 Ghana Cedis (column 1).

[Table 8 Lineage group, family labor and rubber yield]

We see in column 2 that larger household size lowers the yield of family-provided lands, as is indicated in the negative coefficient of the interaction term between the number of adult household members and the share of family-provided lands. The negative coefficient of family-provided lands declines by half in size and turns insignificant by controlling for the interaction effect. These indicate that the negative impact of household size on family-provided lands accounts for a significant portion of the yield gap between family-provided and non-family lands.

The same does not apply to the effect of household size. In column 3, an interaction term between the size of the lineage group and the share of family-provided lands is included. It shows that larger lineage group size is linked with lower yield in the family-provided lands, as the negative coefficient of the interaction term indicates. However, controlling for the lineage group size effect does not significantly lower the negative coefficient of family origin. Comparing with the result in column 2, it suggests that certain household-level, rather than lineage-group factor is relevant for explaining the low yield of family lands. On the basis that both the risk of re-appropriation of lands and the pressure to re-distribute output occur

through matrilineal ties, these hypotheses explain, at most, only a tiny portion of the low yield of family-provided lands.⁶

The question is whether this link between larger household size and lower yield in family lands is attributed to the labor shirk of the household members employed in those farm plots. From column 4, larger household size increases the wage payment per hectare, suggesting that household members are hired in the family plots and paid for their labor. We see from column 5 that it is not the case for lineage members: lineage group size does not augment the wage labor in family lands. These suggest that only the household-level group size influences the number of kinship members employed in the family lands. Do the results so far suggest that yield is low because family members shirk in the family-provided lands? We see from columns 6 and 7 that neither a larger number of household laborers nor a larger lineage group size lowers the productivity of hired labor from those groups. Furthermore, from column 8, the productivity of hired labor is higher in family-provided lands. Although some reservation is required because the data do not include the exact information on the number of persons employed from the household members and the lineage group, considering all these, labor shirk of family labor or those employed from lineage groups is not likely to account for the lower yield in family lands.

Table 9 looks at how the spending for seedlings and fertilizer is affected by the family origin and perceived rights.⁷ Values that the household spent on farm inputs are observed at the household level but not at the plot level. Therefore, the dependent variable is the total value the households spent per hectare for the entire household rubber plots. The explanatory variables are accordingly redefined at the household level.⁸ The same set of control variables as previous tables are included.

[Table 9 Farm expenses per hectare of rubber plots: rubber cultivator households]

Throughout Table 9, the low yield in family-provided lands is associated only with the input intensity of seedlings but not with fertilizer. The low input of seedlings explains the

yield of family-provided lands, but fertilizer inputs do not. Columns 1 to 5 show the results of expenses for seedlings. With any of the specifications, the share of family-provided lands is negatively related to spending on seedlings. The size of the negative effect, -179.7 in column 1, amounts to 77% of the sample mean 231 Ghana Cedis. Column 2 shows that the land tenure reconciliation had no impact on seedling inputs, and controlling for the effect of tenure reconciliation does not much reduce the coefficient of family origin of lands. Column 3 includes the land rights. None of the land rights categories are found to be relevant to seedling inputs, and controlling for the land rights does not affect the negative coefficient of family-provided lands. Therefore, land rights do not explain why family origin negatively affects the input of seedlings.

Column 4 includes a binary variable that captures households' uptake of input loans from the rubber company. Loans are significantly linked with higher seedling expenses. Column 5, where an interaction term of family origin of lands and a dummy variable for uptake of input loan is added, shows a lower effect of loan uptake in family-provided lands, suggesting the amounts borrowed are low in those lands. The input of seedlings is often at a very low level or utterly zero in family-provided lands.⁹ A similar is frequently observed in case the households do not uptake the company's input loans.

It is a puzzle that the negative coefficient of the family-provided dummy is not affected by controlling for the loan uptake in columns 4 and 5. Also, the irrelevance of the land rights with the expenses cannot be consistently interpreted, as significant linkages are found between mortgage rights and the gift rights with the yield (Table 7) and between the gift rights with loan uptake (Table 10). The results are likely to be affected by a recall error, particularly regarding the expenses on seedlings. The outgrowers often do not recognize the amount of loan they borrowed, that is, the exact amount expensed, because the company's loans are provided in loans in kind and repaid in deductions from the output.

The last three columns of the table look at the fertilizer expenses per hectare of rubber plots. With any of the specifications, the family origin status of lands is not affecting per

hectare input of fertilizer. It starkly contrasts with the very firm negative impacts observed for seedlings. The positive effect of the reconciliation on fertilizer input is observed in column 6, in contrast to its irrelevance with the seedlings input (column 2). These suggest that the positive effect of the reconciliation on the yield that was seen in Table 6 and Table 7 is likely to be its impact through an increase in the fertilizer input but not of seedlings. The intervention did not remedy the negative effect on family lands since the productivity gap in the family lands accrues almost entirely to the low initial input of seedlings.

Results on fertilizer input with land rights in column 7 show that the right to rent out is positively related to fertilizer input. Does this indicate that the investment incentives to augment transfer value are at work? The differences between owned plots and tenant plots between owned and rented lands may have led to these coefficient estimates through the differences in the right to rent out. A similar may apply to the negative coefficient of the right to nominate an heir. Column 8 shows the results restricting the sample to non-tenant lands to exclude such a possibility. The effect of transfer rights (and inheritance rights) turns statistically insignificant. The transfer value view may not be a rigorous explanation for fertilizer input. The effect of transfer rights, if any, pertains solely to fertilizer input that may be relevant in explaining the productivity of the entire rubber plots. However, it does not explain the productivity gap in the family-provided lands.

Table 10 examines how land rights and the lands' family origin affect access to the input loans. The dependent variable is measured in binary indicator of the rubber household's uptake of loans.¹⁰ Columns 1 to 3 show the results of seedling loans. The results in column 1 indicate that land obtained via family ties is 15% less likely to obtain seedling loans. Column 2 includes land tenure reconciliation which is not found to enhance the acquisition of seedling loans.

[Table 10 Acquisition of loans, family origin of lands, and land rights]

The land rights are included in column 3. A notable result is that gift rights are neg-

actively related to loans. That is, when households have independent land rights that are strong enough to pursue inheritance of the land without consent from the lineage group, it reduces the households' choice to obtain company loans. It contrasts with the conventional presumption that stronger land rights lead to more investment. The negative coefficient of the family-provided dummy becomes smaller when the land rights are included, and its statistical significance declines, indicating that some part of the negative association of family-provided lands and loan take-ups is explained by the right to give as a gift.

Columns 4 to 8 show the results of fertilizer loans. Family origin is not related to loan uptakes in any of these specifications, indicating that differences in fertilizer loans are irrelevant in explaining the low productivity in family-provided lands, similarly to the results regarding fertilizer input in Table 9. In column 5, tenure reconciliation is positively and significantly related to access to fertilizer loans. It is, however, not likely that the intervention remedied or reception of it explains the negative impact of family-origin lands as long as the impact is found only on fertilizer. In column 6, gift right is negatively related, and mortgage right is positively related to fertilizer loans. Columns 7 and 8 restrict the sample to non-tenants, where previous results in Columns 5 and 6 are qualitatively maintained.¹¹

Throughout Table 10, the family origin of lands crucially reduces the uptake of the loans for seedlings, while it does not affect the loans for fertilizer. The same is observed for the input expenses of seedlings and fertilizer in Table 9. Seedlings are sown with very low intensity in some of the family-provided lands. The expenses on seedlings are exceptionally low or utterly zero for some of the family-provided lands.¹² While the mortgage rights do not account for the low expenses and loan uptakes (Tables 9 and 10), lower loan uptakes are clearly linked to lower inputs of seedlings.¹³

4.2 Interpretation of the Results

This section interprets the results and discusses what can explain the investment and yield gap in the family-provided lands. As is suggested by the results that have been seen so far, it reveals that the conventional hypotheses that relate overlapping and weak land rights with low investment do not fully account for the low yield in the family lands.

From the results about input and loans, the negative association of family origin of lands is observed for the expenses and loans only of seedlings but not for those of fertilizer (Tables 9 and 10). That is, the low rubber yield in family-provided lands primarily pertains to the input intensity of initial investment. The sparse planting at the beginning explains the subsequent low expenses on fertilizers and yield in those lands.

Most suggestive of the low input use and yield in family-provided lands is the difference in the perceived land rights: coefficients of family origin decline by around one-half when mortgage rights and gift rights are controlled for (Table 7). Of those two, mortgage rights do not account for the yield lag in the family-provided lands. The collateral function of lands was found relevant only to the loans for fertilizer but not those for seedlings, whereas the low yield in the family-provided comes solely from the input and loans of seedlings (Table 9 and 10).

The right to give as a gift is consistently found to suppress loan uptakes (Table 10) and the unit yield (Table 7). A strong individual right to pursue intra-household inheritance is linked with the low intensity of seedling inputs. Furthermore, controlling for the gift right most significantly reduces the size of the negative effect of family origin (Tables 7 and 10). That is, the gift rights account for the largest portion of the productivity gap in those lands. These negative associations contradict the conventional property rights theory, implying that the issue is not the security of land holdings. Some risk aversion, rather than the security of land rights, would more effectively interpret such aversion of investment in lands vested with individualized rights.

Relatedly, the reason for the negative association between household size and the yield in family-provided lands observed in column 2 of Table 8 remains to be interpreted. The number of adult household members explains the negative impact of family-provided lands in the presented result. A similar result is observed when the number of minor members is used, as the number of dependent minors positively correlates with the number of adults in the household. A household tends to avoid the risk of investing in rubber or dedicating family lands to rubber when it has a larger number of minor members it has to support. Such an interpretation is in line with the association of intra-household inheritance rights with the reluctance against investment in rubber plots.

5 Conclusion

The empirical results consistently indicated that the family origin of lands deters the adoption of rubber cultivation, unit yield, input use, and access to input loans. The paper has explored why obscure land rights of these lands under customary land tenure systems hold back farm investment and whether the title registration and rubber company's intervention in land tenure reconciliation had an effect in removing such disincentives.

The empirical results indicated that title registration did not affect the adoption of rubber cultivation or yield after tree planting. As titling is voluntary, the positive correlation reflects the originally strong land rights. I did not find a causal linkage where clearer land rights enhance investment. Titling could be better understood as attempts to facilitate administrative procedures in response to increased investment opportunities in cash crops and the need to reduce conflicts.

The rubber company's intervention to reconcile land tenure with the lineage group of prospective outgrowers shows a positive association with both the adoption and yield of rubber cultivation, but these linkages were not established as causal relationships. The cultivators' inherent land rights, the mortgage rights, in particular, explain the access to

the intervention. The effect of the reconciliation is a seeming one that reflects the selectivity according to the land right. Either of these interventions did not remedy the low input, loan access, and productivity of rubber cultivation.

Regarding the reason overlapping land rights lower investment and yield in those family-provided lands, empirical results did not support the hypotheses that attribute investment disincentives to the re-distributive pressure on output or the risk of re-appropriation of lands. The size of the lineage group, which would augment the re-distribution pressures or re-appropriation, accounts for only a small portion of the gap between the family and non-family lands, albeit it reduces the overall productivity of rubber plots. The labor shirk of household members does not account for the productivity gap in the family lands either, in contrast to what was found in Guirkinger et al. (2015). A larger number of adult household members leads to more paid family labor, but it does not reduce the productivity of family-provided lands.

The collateral function of lands, as measured in the perceived right to mortgage the land, is found to augment the productivity of rubber growers in general by enhancing access to the rubber company's fertilizer loans and land tenure reconciliation. However, it does not account for the low yield in the family-provided lands. An overwhelming part of the low yield in those lands accrues from low loan uptakes and low input intensity of seedlings at the startup, in which the presence or absence of mortgage rights is found irrelevant. Even after some portion of the plot is planted with rubber, the input intensity of seedlings is often very low in family-provided lands, leaving significant spaces in rubber plots vacant.

The land right to give as a gift, which gives the households freehand to perform within-household inheritance without the involvement of lineage members, is strongly and negatively related to the initial investment of seedlings and unit yield. Moreover, the presence or absence of gift rights is the most important determinant of the investment gap between family-provided and other types of land. Households tend to avoid investment in rubber when the lands are obtained via family ties, or when the investment is made, the invest-

ment intensity and yield are often extremely low. These tendencies are amplified when the households have gift rights and a larger number of household members.

Such a finding sharply contradicts what the property right theory predicts. Unclearly defined rights do not explain the observed household choices since the low investment is more prominent when the households have more individualized and stable land rights rather than a lack of them. It could only be understood that households have preferences to avoid investment risk in using family lands, which are reserved for food production or conventional cash crops, even after some portion of the plot is planted to rubber. Certain conventions and norms may also be involved, such as the family lands should be dedicated to food production or conventional cash crops that are perceived as reliable financial sources that support the entire life stage of children.

References

- Abdulai, Awudu, Victor Owusu, and Renan Goetz. 2011. "Land Tenure Differences and Investment in Land Improvement Measures: Theoretical and Empirical Analyses." *Journal of Development Economics* 96:66–78.
- Ali, Daniel Ayalew, Klaus Deininger, and Markus Goldstein. 2014. "Environmental and Gender Impacts of Land Tenure Regularization in Africa: Pilot Evidence from Rwanda." *Journal of Development Economics* 110:262–275.
- Amanor, Kojo S. 2001. "Land, Labour and Family in Western Ghana: A Critique of Land Policy under Neo-Liberalism." Nordiska Africainstitutet Research Report no. 116.
- Asaaga, Festus A., Mark A. Hiron, and Yadvinder Malhi. 2020. "Questioning the Link between Tenure Security and Sustainable Land Management in Cocoa Landscapes in Ghana." *World Development* 130(C).
- Atwood, David A. 1990. "Land Registration in Africa: The Impact on Agricultural Production." *World Development* 18(5):659–71.
- Austin, Gareth. 2005. *Labour, Land, and Capital in Ghana: From Slavery to Free Labour in Asante, 1807–1956*. University of Rochester Press, Rochester, NY.
- Besley, Timothy. 1995. "Property Rights and Investment Incentives: Theory and Evidence from Ghana." *Journal of Political Economy* 103, no. 5:903–937.
- Berry, Sara. 1993. *No Condition is Permanent: The Social Dynamics of Agrarian Change in Sub-Saharan Africa*. Madison, WI: The University of Wisconsin Press.
- . 2018. "Who Owns the Land? Social Relations and Conflict over Resources in Africa." GLOCON Working Paper no. 7.

- Brasselle, Anne-Sophie, Frédéric Gaspart, and Jean-Philippe Platteau. 2002. “Land Tenure Security and Investment Incentives: Puzzling Evidence from Burkina Faso.” *Journal of Development Economics* 67:373–418.
- Bruce, John W., and Shem E. Migot-Adholla ed. 1994 “Searching for Land Tenure Security in Africa.” Washington, DC: World Bank.
- Byerlee, Derek, Alain De Janvry, Elisabeth Sadoulet, Robert Townsend, and Irina Klytchnikova. 2008. *World Development Report 2008 : Agriculture for Development*. World Development Report no. 30, Washington DC: World Bank Group.
- Chimhowu, Admos. 2019. “The ‘New’ African Customary Land Tenure. Characteristic, Features and Policy Implications of a New Paradigm.” *Land Use Policy* 81: 897–903.
- Coase, Ronald H. 1937. “The Nature of the Firm.” *Economica* 4:386–405.
- . 1960. “The Problem of Social Cost.” *Journal of Law and Economics* 3:1–44.
- Cotula, Lorenzo, Camilla Toulmin, and Ced Hosse. 2004. “Land Tenure and Administration in Africa: Lessons of Experience and Emerging Issues.” London: International Institute for Environment and Development.
- Crook, Richard C. 2008. “Customary Justice Institutions and Local Alternative Dispute Resolution: What Kind of Protection Can They Offer to Customary Landholders?” in *Contesting Land and Custom in Ghana*. ed. Janine M. Ubink and Kojo S. Amanor. Leiden: Leiden University Press.
- Deininger, Klaus. 2003. “Land Policies for Growth and Poverty Reduction.” World Bank Policy Research Report. Washington, DC: World Bank and Oxford University Press.
- Deininger, Klaus, and Sonqing Jin. 2006. “Tenure Security and Land-related Investment: Evidence from Ethiopia.” *European Economic Review* 50, no. 5:1245–1277.

- Di Falco, Salvatore, and Erwin Bulte. 2011. "A Dark Side of Social Capital? Kinship, Consumption and Savings." *Journal of Development Studies* 47(8):1128–1151.
- Di Falco, Salvatore, Francesco Feri, Paolo Pin, and Xavier Vollenwider. 2018 "Ties that Bind: Network Redistributive Pressure and Economic Decisions in Village Economies." *Journal of Development Economics* 131:123–131.
- Fafchamps, Marcel. 1992. "Solidarity Networks in Rural Africa: Rational Peasants with a Moral Economy?" *Economic Development and Cultural Change* 41.
- Feder, Gershon, Onchan, Tongroj, Chalamwong, Yongyuth, and Chira Hongladarom. 1988. *Land Policies and Farm Productivity in Thailand*. Baltimore: Johns Hopkins University Press (for World Bank).
- Feder, Gershon, and David Feeny. 1991. "Land Tenure and Property Rights: Theory and Implications for Development Policy." *World Bank Economic Review* 5, no. 1:135–153.
- Fenske, James. 2011. "Land Tenure and Investment Incentives: Evidence from West Africa." *Journal of Development Economics* 95:137–156.
- Fold, Niels, and Lindsay Whitfield. 2012. "Developing a Palm Oil Sector: The Experiences of Malaysia and Ghana Compared." DIIS Working Paper 2012.08.
- Goldstein, Marcus and Christopher Udry. 2008. "The Profits of Power: Land Rights and Agricultural Investment in Ghana." *Journal of Political Economy* 116, no. 6:981–1023.
- Guirkinger, Catherine, Jean-Philippe Platteau, and Tatiana Goetghebuer. 2015. "Productive Inefficiency in Extended Agricultural Households: Evidence from Mali." *Journal of Development Economics* 116:17–27.
- Hall, Ruth, Ian Scoones, and Dzodzi Tsikata. 2017. "Plantations, Outgrowers and Commercial Farming in Africa: Agricultural Commercialisation and Implications for Agrarian Change." *Journal of Agrarian Change* 44, no. 3: 515–537.

Holden, Stein T., and Keiji Otsuka. 2014. "The Roles of Land Tenure Reforms and Land Markets in the Context of Population Growth and Land Use Intensification in Africa." *Food Policy* 48:88–97.

Kasanga, Kasim, and Nii Ashii Kotey. 2001. *Land management in Ghana: Building on Tradition and Modernity*. International Institute for Environment and Development, London.

Lambrecht, Isabel, and Sarah Asare. 2015. "Smallholders and Land Tenure in Ghana: Aligning Context, Empirics, and Policy." IFPRI Discussion Paper 01492.

Lavigne Delville, P. 2000. Harmonising Formal Law and Customary Land Rights in French-Speaking West Africa?, in *Evolving Land Rights, Policy and Tenure in Africa*. ed. Camilla Toulmin and Jullian Quan. London: IIED, NRI and DFID.

Migot-Adholla, Shem E., Frank Place, and Willis Oluoch-Kosura. 1994. "Security of Tenure and Land Productivity in Kenya." In *Searching for Land Tenure Security in Africa*, ed. John W. Bruce and Shem E. Migot-Adholla. Iowa: Kendall/ Hunt Publishing Cy.

Migot-Adholla, Shem E., George Benneh, Frank Place, and Steven Atsu 1994. "Land, Security of Tenure, and Productivity in Ghana." In *Searching for Land Tenure Security in Africa*, edited by John W. Bruce and Shem E. Migot-Adholla. Quincy, MA: Kendall Hunt.

North, Douglas C. 1981. *Structure and Change in Economic History*. New York: Norton.

Otsuka, Keiji, S. Suyanto, Tetsushi Sonobe, and Thomas P. Tomich. 2001. "Evolution of Land Tenure Institutions and Development of Agroforestry: Evidence from Customary Land Areas of Sumatra." *Agricultural Economics* 25:85–101.

Otsuka, Keiji, Agnes R. Quisumbing, Ellen Payongayon, and J. B. Aidoo. 2003. "Land Tenure and the Management of Land and Trees: The Case of Customary Land Area of Ghana." *Environment and Development Economics* 8, no. 1:77–104.

Pinckney, Thomas C., and Peter K. Kimuyu. 1994. "Land Tenure Reform in East Africa: Good, Bad or Unimportant?" *Journal of African Economies* 3, no. 1:1–28.

Place, Frank. 2009. "Land Tenure and Agricultural Productivity in Africa: A Comparative Analysis of the Economics Literature and Recent Policy Strategies and Reforms." *World Development* 37:1326–1336.

Place, Frank, and Peter Hazel. 1993. "Productivity Effects of Indigenous Land Tenure Systems in Sub-Saharan Africa." *American Journal of Agricultural Economics* 75:10–19.

Place, Frank, and Shem E. Migot-Adholla. 1998. "The Economic Effects of Land Registration on Smallholder Farms in Kenya: Evidence from Nyeri and Kakamega Districts." *Land Economics* 74, no. :360–373.

Platteau, Jean-Philippe. 1991. "Traditional System of Social Security and Hunger Insurance: Past Achievements and Modern Challenges." in *Social Security in Developing Countries*. ed. Ehtisham Ahmad, Jean Drèze, John Hills, and Amartya Sen. Oxford: Clarendon Press.

Platteau, Jean-Philippe. 1995. "Reforming Land Rights in Sub-Saharan Africa: Issues of Efficiency and Equity." UNRISD Discussion Paper no. 60.

———. 1996. "The Evolutionary Theory of Land Rights as Applied to Sub-Saharan Africa: A Critical Assessment." *Development and Change* 27:29–86.

———. 2000. *Institutions, Social Norms, and Economic Development*. London and New York: Routledge.

Quan, Julian, Janine Ubink, and Adarkwah Antwi. 2008. "Risks and opportunities of state intervention in customary land management: Emergent findings from the Land Administration Project Ghana." in *Contesting Land and Custom in Ghana*. ed. Janine M. Ubink and Kojo. S. Amanor. Leiden: Leiden University Press.

Quisumbing, Agnes R., Ellen Payongayoung, J. B. Aidoo, and Keijiro Otsuka. 2001a. “Women’s Land Rights in the Transition to Individual Ownership: Implications for Tree-resource Management in Western Ghana.” *Economic Development and Cultural Change* 50, no. 1:157–182.

Quisumbing, Agnes R., J. B. Aidoo, Ellen Payongayon, and Keijiro Otsuka. 2001b “Agroforestry Management in Ghana.” in *Land Tenure and Natural Resource Management: A Comparative Study of Agrarian Communities in Africa and Asia*. ed. Keijiro Otsuka and Frank Place. International Food Policy Research Institute. The Johns Hopkins University Press, Baltimore and London.

Udry, Christopher. 1996. “Gender, Agricultural Production, and the Theory of the Household.” *Journal of Political Economy* 104, no. 5:1010–1046.

Yamano, Takashi., Frank Place, W. Nyangena, Julliet Wanjiju, and Keijiro Otsuka. 2009. “Efficiency and Equity Impacts of land Markets in Kenya.” in *The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency*. ed. Stein T. Hoden, Keijiro Otsuka, and Frank Place. Washington DC: Resources for the Future.

Notes

¹Platteau (2000) offers a comprehensive interpretation encompassing anthropological arguments.

²The land rights of both the husband and the wife are recorded for given plots cultivated by the household.

³The following controls are included: gender of the cultivator, age, years of schooling, gender and marriage status of the household head, household size, lineage group size, total farmland size of the household, year of land acquisition by the household and by the cultivator, and village dummies.

⁴Positions of traditional village office include *abusua panyin* (village chief), *okyame* (lineage head's spokesman), *tufohene* (main advisor to the chief), *mbrantehene* (chief of development issues), *asofohene* (chief of youth issues), and *obaapanin* (queen mother in Akan matrilineal clan).

⁵See Appendix A for how the mode of land acquisition relates to differences in perceived rights.

⁶Support for the re-appropriation hypothesis is further weakened by the fact that the tenure duration is not exceptionally short for lands of family origin. See Appendix B.

⁷See Appendix C for the impact of input use and loans on yield per hectare.

⁸The family origin of lands is defined as the share of the rubber plot size obtained via family ties within the household's total rubber plot size; the tenure reconciliation variable is reconstructed as the share of the household's rubber field that received the intervention before or within one year from tree planting, or zeroes if no household plot received the intervention; the land rights variables are the share of the rubber plot size on which a particular right category is perceived in the household's total rubber plot size.

⁹See Appendix D.

¹⁰Observations of input and loans are adjusted to match the household-level observation, and plot-level variables (reconciliation and land rights) are reconstructed and converted to household-level.

¹¹There are reasons to suspect the endogeneity of the gift rights, such as reverse causality or correlation with other land rights. The possible endogeneity of gift rights (columns 3, 6, and 8) and tenure reconciliation (columns 5 and 7) was examined. With a valid set of instruments, the exogeneity of these variables was found to be very far from being rejected. They are treated as exogenous in the results presented in the table.

¹²See Figure D1 of Appendix D.

¹³See Figure D2 of Appendix D.

Table 1: Summary Statistics

	Number of Observations	Mean (Percentage)
Plot-level variables		
Male cultivator	454	(83.9)
Female cultivator	87	(16.1)
Land size (hectare)	541	2.9
Year of acquisition, family	541	1918.1
Year of acquisition, cultivator	541	2001.0
Value per parcel (Ghana Cedi/hectare)		
Food crop	85	1777.0
Cocoa	84	582.3
Oil palm	61	650.3
Rubber	296	3458.4
Interventions in land tenure		
Company's land tenure reconciliation	143	(26.4)
Title registration	231	(42.7)
Instrumental variables for interventions and land rights:		
Distance to plots from residence (kilometers)	541	4.0
Family's status in village / mother's status in marriage		
Mother is the first wife of father	322	(59.5)
Number of wives of father	541	2.1
Number of children of father	541	9.6
Measures of input use and extended family		
Farm expenses per hectare of rubber plots (Ghana Cedi)		
For seedlings	183	165.8
For fertilizer	183	130.9
For pesticides	183	125.0
For wages	183	390.4
Acquisition of loans (percent)		
For seedlings	183	(29.4)
For fertilizer	183	(36.7)
For pesticides	183	(8.8)
For wages	183	(1.5)
Extended family		
Number of children of mother	183	5.97
Number of adult members of the household	183	4.09
Number of household members living apart	183	1.38
Proportion of inherited or allocated land	183	.50
Total land size of rubber plots	183	5.89
Household-level variables		
Akan households	192	(84.2)
Moslem (non Akan) households	36	(15.8)
Female headed household	26	(11.4)
Age of household head	228	46.6
Years of schooling of HH head	228	8.9
Household size	228	6.0

Note. Percentages are shown in parenthesis for binary indicators and categorical variables.

Table 2: Interventions in Land Tenure by Crop and Gender

	All Crops		Food Crop		Cocoa		Oilpalm		Rubber	
Males' plots										
Tenure reconciled	120	(26.4)	1	(0.2)	5	(1.1)	1	(0.2)	133	(29.3)
Title registered	191	(42.1)	21	(4.6)	20	(4.4)	10	(2.2)	140	(30.8)
All males	454	(100.0)	56	(12.3)	76	(16.7)	58	(12.8)	264	(58.1)
Females' plots										
Tenure reconciled	23	(26.4)	0		0		0		23	(26.4)
Title registered	40	(46.0)	1	(1.1)	1	(1.1)	3	(3.4)	35	(40.2)
All females	87	(100.0)	28	(32.2)	9	(10.3)	3	(3.4)	47	(54.0)
All cultivators	541		84	(15.5)	85	(15.7)	61	(11.2)	311	(57.4)

Note. Percentage shares within all males' plots or within all females' plots are shown in parenthesis.

Table 3: Perceived Rights and Interventions in Land Tenure (%)

	Tenure			Title	
	All	Reconciled	Difference	Registered	Difference
Male cultivator					
To plant trees	88.1	88.1	(-0.1)	85.8	(-4.1)
To cultivate after fallow	77.9	78.4	(0.7)	75.4	(-4.4)
To bequeath or nominate heir	55.7	55.2	(-0.7)	54.5	(-2.1)
To rent out	46.5	47.8	(1.8)	44.1	(-4.2)
To sell outright	19.7	18.7	(-1.5)	19.4	(-0.5)
To give as gift	22.5	26.1	(4.9)	28.0	(9.4)**
To mortgage	33.2	42.5	(12.8)***	32.7	(-0.9)
Number of observations	497	134		211	
Female cultivator					
To plant trees	70.2	71.2	(1.3)	69.8	(-0.7)
To cultivate after fallow	49.8	54.2	(6.1)	48.0	(-2.9)
To bequeath or nominate heir	31.1	37.3	(8.4)*	33.0	(3.1)
To rent out	25.9	34.7	(12.1)***	27.4	(2.4)
To sell outright	9.8	12.7	(4.0)	10.6	(1.4)
To give as gift	11.4	13.6	(3.0)	14.5	(5.3)*
To mortgage	17.7	28.8	(15.1)***	17.9	(0.3)
Number of observations	75	22		179	

Note. The numbers in parentheses show the percentage point differences between the treated and untreated groups. The signs indicate the significance levels of t -tests for the differences.

*** $p < .01$.

** $p < .05$.

* $p < .10$.

Table 4: Mode of Land Acquisition and Interventions in Land Tenure

Mode of land acquisition	Number of Plots	Tenure Reconciled		Title Registered	
		Percentage	Difference	Percentage	Difference
Allocated from lineage group	134	16.4	(-13.3) ^{***}	35.8	(-9.1) ^{**}
Inherited (matrilineal)	137	20.4	(-8.0) [*]	47.4	(6.4)
Transfer from father	31	48.4	(23.3) ^{***}	32.3	(-11.1)
Appropriated from village	24	50.0	(24.7) ^{***}	58.3	(16.4)
Rented in	168	31.5	(7.4) [*]	42.3	(-0.6)
Purchased	39	28.2	(1.9)	56.4	(14.8) [*]
Other	8	25.0	(-1.5)	12.5	(-30.7) [*]
All	541	26.4		42.7	

Note. Numbers in parentheses show the differences between the percentages treated within the given mode of land acquisition and those treated among all lands. The signs indicate the significance level of the *t*-tests performed for the differences.

*** $p < .01$.

** $p < .05$.

* $p < .10$.

Table 5: Investment in Tree Planting (Entire Farm Plots, $N=541$)

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	IV/ ¹	OLS	IV/ ²	OLS	IV/ ³
Family-provided lands	-.147*** (2.77)	-.027 (.12)	-.167*** (3.28)	-.162*** (2.74)	-.038 (.77)	-.149* (1.61)
Land titled			.211*** (4.70)	.152 (.44)		
Land tenure reconciled					.453*** (11.89)	-.006 (.02)
R-squared	.29	.28	.33	.33	.44	.29
Robust score test of exogeneity (p -value)		.60		.86		.10

Note. Heteroskedasticity-robust standard errors are shown in parenthesis.

*** $p < .01$.

* $p < .10$.

¹Family-provided dummy is instrumented in column 2.

²Land titling is instrumented in column 4.

³Land tenure reconciliation is instrumented in column 6.

Table 6: Yield Value per Hectare and Family Lands, Impact of Interventions (Rubber Plots, $N=294$)

	DV: Yield per Hectare			DV: Tenure Reconciliation	DV: Yield per Hectare	
	OLS (1)	OLS (2)	OLS (3)	OLS (4)	2SLS ^{/1} (5)	OLS (6)
Family-provided land (Inherited or allocated)	-773.4* (1.73)	-786.0* (1.72)	-421.9 (.88)	-.266*** (3.93)	-312.1 (.57)	-748.6 ^{/2} (1.36)
Land titled		68.1 (.15)				
Land tenure reconciled			1118.1** (2.03)		859.2 (.74)	1191.5* ^{/2} (1.80)
Reconciliation \times family-provided						1081.1* (1.92)
Female cultivator	735.2 (.47)	364.9 (.46)	438.7 (.56)	.044 (.45)	233.7 (.64)	382.9 (1.06)
Moslem household	-618.4 (1.06)	-612.0 (1.06)	-559.1 (.97)	-.0006 (.01)	-504.8 (1.20)	-564.8 (1.36)
Year of land acquisition	-62.3*** (2.94)	-62.6*** (2.94)	-53.2** (2.47)	-.006* (1.93)	-52.6** (2.24)	-51.9** (2.20)
Tree age	163.2*** (5.65)	162.9*** (5.65)	164.5*** (5.77)	.010***	158.4** (2.64)	161.8*** (2.57)
Married	735.2 (1.32)	734.3 (1.32)	743.0* (1.35)	-.088 (1.02)	403.5 (.87)	549.3* (1.34)
Age of household head	1.21 (.05)	1.07 (.05)	6.44 (.33)	-.003* (1.25)	8.55 (.47)	5.16 (.31)
Years of schooling of household head	77.3 (1.58)	77.8 (1.58)	69.7** (1.42)	.006 (.85)	73.6 (1.50)	73.5* (1.59)
Inverse Mills' ratio	-2290.7 (.97)	-2118.1 (.81)	2381.3 (.73)	-.904 (1.39)	5397.4 (.78)	2594.5 (1.24)
Distance from residence				-.037*** (3.73)		
Office holding status of household head				-.024 (.37)		
Number of wives of father				-.050* (1.92)		
Wife order of mother				-.119* (1.75)		
Number of children of father				.0006 (.12)		
Village dummies	Yes	Yes	Yes	Yes	Yes	Yes
R -squared	.26	.26	.27	.17	.32	.32
Robust score test of exogeneity (p -value)					.77	

Note. Heteroskedasticity-robust t -statistics are shown in parentheses.

*** $p < .01$,

** $p < .05$,

* $p < .10$.

^{/1}In column 5, tenure reconciliation is instrumented.

^{/2}Average marginal effects of the main terms are shown in the regression with interaction terms.

Table 7: Impacts of Perceived Rights on Yield Value per Hectare (Non-tenant Rubber Plots, $N=192$)

	DV: Yield value per hectare				DV: Tenure reconciliation		Yield per Ha	
	OLS		IV ^{/1}	OLS	OLS	IV ^{/2}	OLS	IV ^{/1}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Family-provided land	-1419.1** (2.06)	-787.2 (1.09)	-208.8 (.24)	-862.8 (1.16)	-.270*** (3.86)	-.169 (1.43)	516.6 (.70)	96.3 (.10)
Land tenure reconciled				1459.1* (1.90)			904.1 (.26)	-317.3 (.24)
Perceived rights:								
To plant trees		-939.9 (.65)	-821.7 (.60)		-.325** (2.32)	-.304** (2.21)		
To nominate heir (matrilineal)		-68.7 (.07)	-468.8 (.44)		.021 (.21)	-.047 (.39)		
To give as gift		-2620.9** (2.24)	-3480.7** (2.55)		-.106 (.93)	-.255 (1.24)	-2264.4*** (2.70)	-6017.8 (1.45)
To rent out		253.7 (.27)	-381.1 (.36)		-.057 (.63)	-.168 (1.28)		
To sell outright		170.0 (.15)	-305.5 (.27)		-.151 (1.39)	-.234 (1.57)		
To mortgage		1795.6** (2.12)	4329.5 (1.72)		.387*** (4.69)	.827* (1.90)	1537.2* (1.88)	5087.1 (1.28)
<i>R</i> -squared	.40	.44	.41	.41	.57	.57	.44	.36
Robust score test of exogeneity (<i>p</i> -value)			.50			.32		.58

Note: Heteroskedasticity-robust standard errors are shown in parentheses. All other controls are included.

*** $p < .01$.

** $p < .05$.

* $p < .10$.

^{/1}Mortgage right and gift right are instrumented in column 3 and 8.

^{/2}Mortgage right is instrumented in column 6.

Table 8: Lineage Group, Family Labor, and Rubber Yield

	DV: Yield value per hectare (Non-tenant plots, $N=192$)			DV: Wage expenditure (Non-tenant households, $N=124$)		DV: Yield value per hectare (Non-tenant plots, $N=192$)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of family-provided lands	-1443.8** (2.06)	-723.2 (1.06)	-1394.5** (2.01)	618.5** (2.00)	649.8** (2.08)	-1407.0** (2.01)	-1444.3** (2.06)	-1408.6** (2.04)
Number of adult household members	219.7* (1.84)	201.7* (1.80)	165.4 (1.37)	84.8* (1.77)	50.2 (0.78)	216.6 (1.82)	173.8 (1.60)	189.5 (1.58)
Size of lineage group	159.0 (1.47)	59.9 (0.58)	128.2 (1.19)	18.7 (0.31)	62.9 (1.31)	133.6 (1.22)	207.3* (1.73)	164.3 (1.54)
Wage expenditure per hectare	0.49** (2.15)	0.57*** (2.66)	0.51** (2.28)			.72** (2.50)	0.62** (2.43)	0.55* (1.95)
Number of adult household members × Share of family-provided lands		-967.9** (4.62)		271.6** (2.16)				
Size of lineage group × Share of family-provided lands			-481.2** (2.18)		37.5 (0.34)			
Number of adult household members × wage expenditure per hectare						-0.12 (1.30)		
Size of lineage group × wage expenditure per hectare							-0.11 (1.12)	
Family-provided land × wage expenditure per hectare								2.14** (2.14)
Adjusted R -squared	0.35	0.42	0.36	0.32	0.29	0.35	0.35	0.35

Note: Heteroskedasticity-robust standard errors are shown in parentheses. All other controls are included.

*** $p < .01$.

** $p < .05$

* $p < .10$.

Table 9: Farm Expenses per Hectare of Rubber Plots: Rubber Cultivator Households

	Expenses for seedlings					Expenses for fertilizer		
	All rubber households ($N=183$)					All rubber households	Non-tenants	
	(1)	(2)	(3)	(4)	(5)	($N=183$)	($N=124$)	
	(6)	(7)			(8)			
Proportion of family-provided lands in total household rubber field	-179.7** (2.60)	-178.4** (2.56)	-173.1** (2.32)	-174.9** (2.53)	-177.7*** ^{/2} (2.92)	-89.5 (1.15)	-98.5 (1.15)	-117.9 (.93)
Land tenure reconciled ^{/1}		42.6 (.33)				70.9* (1.75)	37.3 (.57)	
Takeup of input loans				151.8*** (3.28)	147.7*** ^{/2} (2.77)			
Proportion of family origin land × Input loans					-129.4 (1.54)			
Perceived land rights (Corresponding size of household land in hectare)								
To plant trees			-2.42 (.43)			2.78 (.49)		3.58 (.52)
To nominate heir (matrilineal)			-4.64 (1.20)			-3.68* (1.69)		-3.22 (1.00)
To give as gift			4.94 (1.09)			3.06 (.61)		3.30 (.48)
To rent out			.36 (.11)			5.09** (2.35)		5.43 (1.45)
To sell outright			-.76 (.12)			-5.03 (.92)		-5.01 (.77)
To mortgage ^{/3}			-1.30 (.36)			2.79 (1.22)		3.38 (1.03)
Adjusted R -squared ^{/4}	.16	.16	.14	.20	.20	.14	.12	.13

Note: Heteroskedasticity-robust t -statistics are shown in parentheses.

*** $p < .01$.

** $p < .05$.

* $p < .10$.

^{/1}Land tenure reconciliation is counted only for those implemented within a year prior to the interview to make it consistent with the dependent variables, which are measured as the expenses during the latest 12 months.

^{/2}Average marginal effects are shown for the single terms.

^{/3}Mortgage rights are measured as the size of entire household plots vested with the right including non-rubber plots since also the non-rubber plots can possibly be used as collateral.

^{/4}Adjusted R -squared are calculated from non-robust regressions.

Table 10: Acquisition of loans, family origin of lands, and land rights

	All rubber households ($N=183$)					Non-tenants ($N=124$)		
	Loans for seedlings			(4)	(5)	Loans for fertilizer		
	(1)	(2)	(3)			(6)	(7)	(8)
Proportion of family-provided land in total household rubber field	-.151*	-.135	-.118	-.074	-.019	-.051	.004	-.050
	(1.77)	(1.57)	(1.36)	(.81)	(.22)	(.57)	(.03)	(.42)
Land tenure reconciled		.125			.263**		.372**	
		(.94)			(2.21)		(2.47)	
Perceived rights: (Corresponding size of household land)								
To plant trees			-.009			-.001		-.005
			(.86)			(.10)		(.35)
To nominate heir (matrilineal)			-.005			-.002		-.007
			(.83)			(.29)		(.77)
To give as gift			-.015*			-.034***		-.039***
			(1.87)			(4.52)		(4.59)
To rent out			-.0008			.002		.014*
			(.14)			(.32)		(1.74)
To sell outright			.006			.010		.008
			(.84)			(1.30)		(1.02)
To mortgage			.001			.009*		.014**
			(.17)			(1.65)		(2.21)
<i>R</i> -squared	.15	.15	.20	.13	.16	.18	.21	.25

Note: Heteroskedasticity-robust t -statistics are shown in parentheses.

*** $p < .01$.

** $p < .05$.

* $p < .10$.

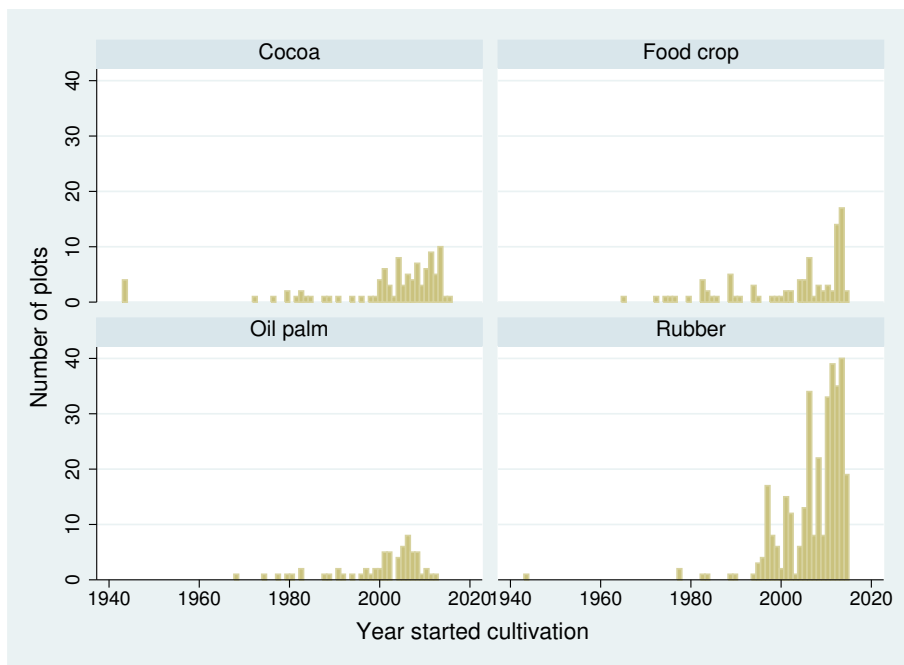


Figure 1: Adoption of Rubber and Other Cash Crop Cultivation

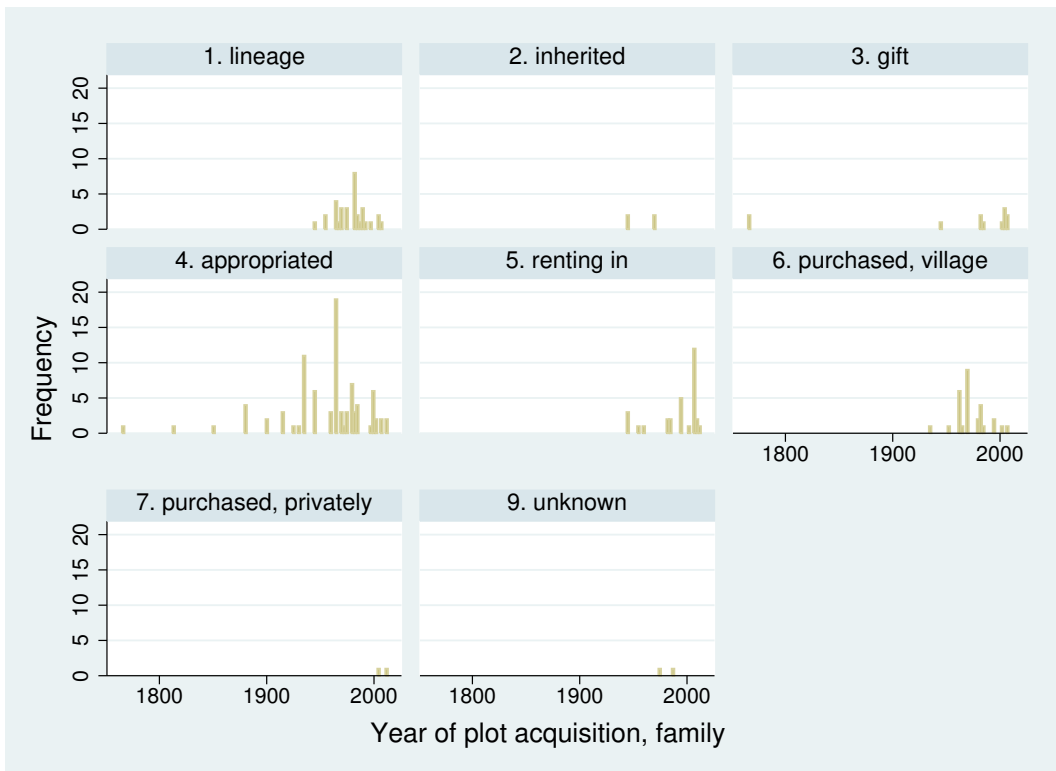


Figure 2: Year of Land Acquisition by Acquisition Mode, Family

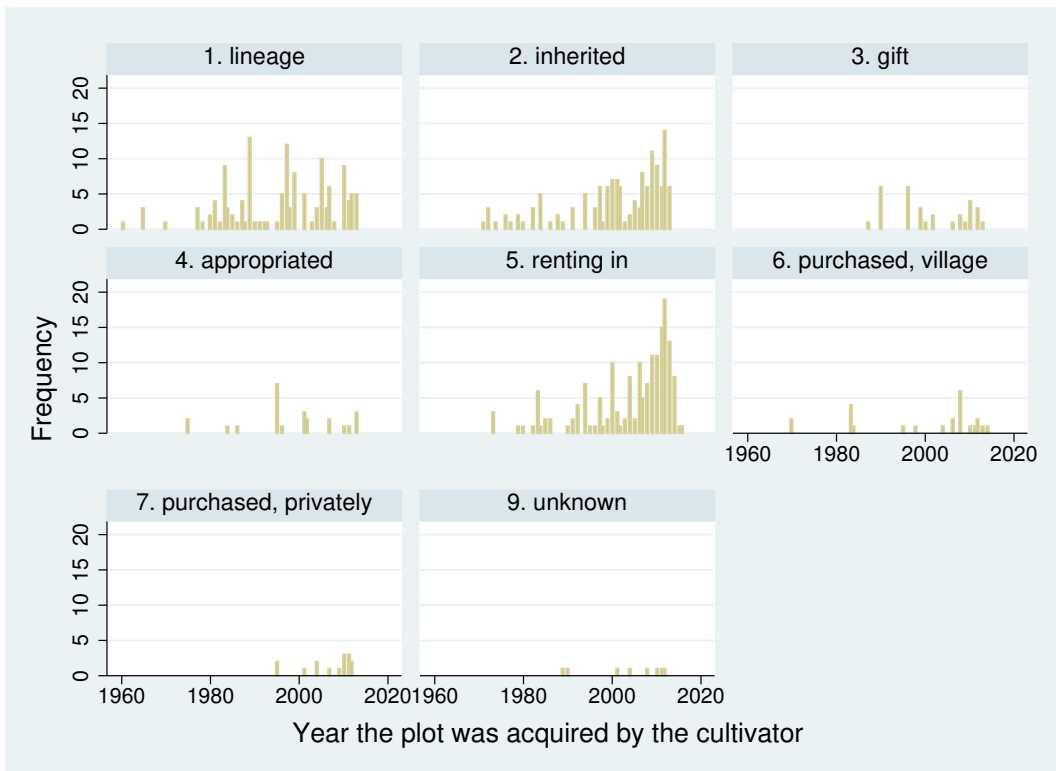


Figure 3: Year of Land Acquisition by Acquisition Mode, Cultivator

Appendix A Land Acquisition Modes and Perceived Land Rights

Table A1: Perceived Land Rights according to Land Acquisition Modes

	DV: perceived land rights					
	(1) Plant trees	(2) Nominate heir	(3) Rent out	(4) Sell outright	(5) Give as gift	(6) Mortgage
Family-provided lands (Entire rubber sample $N=294$)	-.0008 (.03)	.154** (2.54)	.098 (1.50)	.140*** (2.79)	.165*** (2.92)	.036 (.58)
Rented land (Entire rubber sample $N=294$)	-.021 (.64)	-.366*** (5.51)	-.233*** (3.13)	-.192*** (3.62)	-.228*** (4.02)	-.292*** (4.80)
Family-provided lands (Sample excluding rented land $N=192$)	.016 (.33)	-.042 (.58)	-.031 (.41)	.082 (1.13)	.069 (.87)	-.177** (2.43)

Note: All controls are included. Absolute values of heteroschedasticity-robust t -statistics are shown in parentheses.

*** $p < .01$.

** $p < .05$

* $p < .10$.

Appendix B Tenure duration by mode of acquisition

Table B1 shows how family-provided lands are associated with re-appropriation risk. The tenure duration of the current cultivator is shown for each land acquisition mode. In column 1, the years since the cultivator obtained the land are used to measure the mean and standard deviation of his/her land tenure; column 2 uses the years since the cultivator started current cultivation. The first two channels: allocation from lineage group and matrilineal inheritance, are the family-related modes that are particularly subject to overlapping claims on lands.

The distribution of the tenure duration of lands obtained through each acquisition channel is compared with privately purchased lands (category 7), which are vested with the most stable tenure. The differences between the distributions are tested by the Kolmogorov-Smirnov test. The results are shown with the signs of statistical significance in the table. The first two family-related acquisition modes exhibit longer rather than shorter duration than privately purchased lands. Frequent re-appropriation for those lands would be reflected in a larger standard deviation, but such a tendency is not observed. These results indicate that tenure duration is not shorter or notably riskier in lands obtained via family-related channels.

Table B1: Tenure duration by mode of acquisition (years)

	(1)		(2)	
	Tenure duration since acquisition		Tenure duration since start of cultivation	
	Mean	Std. dev.	Mean	Std. dev.
1. Allocation, lineage grp.	19.0**	(11.9)	11.2	(9.4)
2. Matril. inheritance	13.8**	(11.0)	12.1*	(13.0)
3. Gift (non-matril. inher.)	13.9**	(8.3)	9.3	(6.4)
4. Allocation from village	15.2**	(10.1)	12.5	(10.2)
5. Renting in	10.7	(9.3)	8.8	(9.0)
6. Purchasing from village	15.1	(13.6)	9.5	(13.8)
7. Privately purchasing	7.9	(5.5)	5.5	(3.5)

Note: Differences from purchased lands (category 7) are indicated in parentheses. The significance of the differences are tested using Kolmogorov-Smirnov test.

**p<.05.

*p<.10.

Appendix C Impacts of Input Use and Loans on Yield Value per Hectare

Table C1 shows how the input use and loans from the rubber company affect yield value per hectare.¹⁴ Column 1 and 2 shows the impacts of per-hectare spending for seedlings. The negative coefficient of family-provided lands declines in size when the land rights are controlled for, but the impact of seedling input is not affected. Columns 3 and 4 show the effect of loans in kind provided by the company for seedlings, which is captured in a dummy variable that indicates the household did or did not take up the loan. The impact of loans, 1150 Ghana Cedis per hectare is not statistically significant, but quite large compared to the sample average of 1808 Ghana Cedis. The statistical significance further declines when the land rights are controlled for in column 4.

Columns 5 to 7 show how input and loans for fertilizers affect yield value per hectare. The expenses for fertilizer are unrelated to yield in column 5. There may be recall error with respect to the value of inputs in case of loans, when the households do not recognize how much they borrowed because the loan is provided in kind and repaid by deduction when the trees start to yield several years later. The loans for fertilizer are positively related to yield in column 6.

Loans definitely augment the unit yield but the coefficient turns statistically insignificant when land rights are controlled for in column 7. That is, the differences in access to loans are explained by the differences in land rights. The gift rights, which are intra-household inheritance rights, are negatively, and mortgage rights are positively related to access to loans.

¹⁴Households commonly have multiple rubber plots, while the expenses for inputs are observed only at the household level. To close the gap, I assume that the household spending and loan uptake for seedlings were used for plots within one year after the start of cultivation, and the household spending and loans for fertilizers were used for plots within four years after trees were planted, during which fertilizer inputs are required.

Table C1: Impacts of Input Use and Loans on Yield Value per Hectare (Non-tenant Rubber Plots, $N=182$)

	DV: Yield value per hectare						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Family-provided land	-1481.6*	-910.6	-1443.5	-866.0	-1310.8	-1349.1	-832.4
	(1.63)	(.98)	(1.58)	(.99)	(1.43)	(.98)	(.98)
Expenses per hectare for seedlings	.264**	.280**					
	(1.99)	(1.99)					
Input loans for seedlings			1150.1	702.0			
			(1.33)	(.58)			
Expenses per hectare for fertilizer					.347		
					(.74)		
Input loans for fertilizer						714.8*	310.3
						(1.62)	(.61)
Perceived rights:							
To plant trees		-952.5		-985.7			-911.9
		(1.15)		(1.00)			(1.11)
To nominate heir (matrilineal)		41.0		-66.8			-61.7
		(.06)		(.10)			(.10)
To give as gift		-2733.3**		-2697.7**			-2702.7*
		(2.14)		(2.02)			(1.93)
To rent out		340.2		249.0			268.0
		(.48)		(.35)			(.38)
To sell outright		29.9		105.2			181.7
		(.03)		(.11)			(.18)
To mortgage		1816.9*		1850.4*			1804.4*
		(1.89)		(1.85)			(1.74)
Adjusted R -squared ^{/1}	.31	.33	.31	.33	.31	.33	.33

Note: Heteroskedasticity-robust standard errors are shown in parentheses. All other controls are included. Expected tenure duration is measured by the mean of current tenure duration by the acquisition modes within the village. *** $p < .01$, ** $p < .05$, * $p < .10$. ^{/1}Adjusted R -squared are calculated from non-robust regressions.

Appendix D Family origin of lands and expenditure for seedlings, access to loans for seedlings

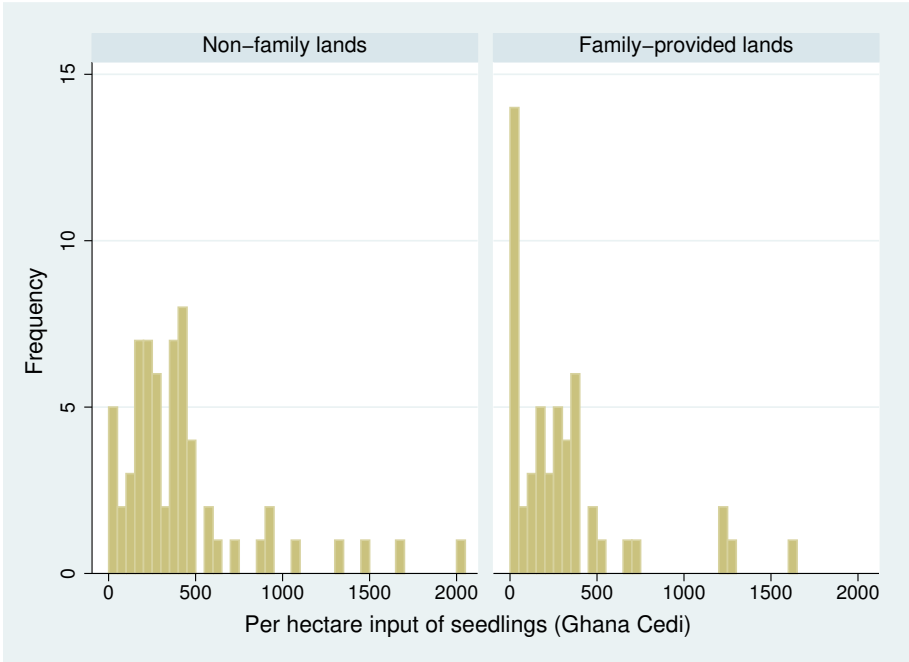


Figure D1: Family origin of lands and spending for seedlings

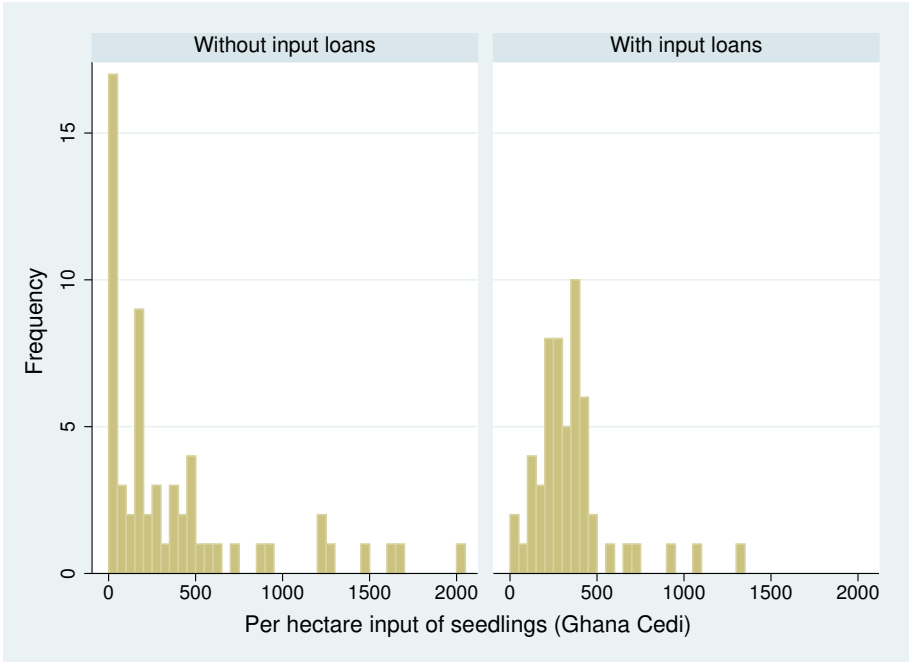


Figure D2: Input loans and spending for seedlings