Productivity Effects Of Indigenous Land Tenure Systems In Sub-Saharan Africa

Frank Place and Peter Hazell

This article uses household survey data from Ghana, Kenya, and Rwanda to test if the indigenous land rights systems in sub-Saharan Africa are a constraint on agricultural productivity. Rights which farmers hold over individual parcels of land vary widely, and are in many cases surprisingly privatized. Yet with few exceptions, land rights are not found to be a significant factor in determining investments in land improvements, use of inputs, access to credit, or the productivity of land. These results cast doubt on the need for ambitious land registration and titling programs at this time.

Key words. land rights, land titling, sub-Saharan Africa

There is a continuing debate about whether the indigenous African land tenure systems are a constraint on land productivity. Some authors, such as Dorner and Harrison, see indigenous tenure systems as static constraints, providing insufficient security to induce farmers to make land improving investments or to induce lenders to finance such investments. Others, such as Cohen, Boserup, Noronha, and Bruce, counter that indigenous tenure arrangements are dynamic and evolve in response to factor price changes. They argue that privatization of land rights, whereby farm households acquire a more complete set of transfer and exclusion rights over their land, occurs as population pressure and agricultural commercialization proceed. If so, the need for widespread land registration and titling programs at this stage of African economic development is called into question.

The debate has been carried on without benefit of rigorous empirical tests of the relationship between indigenous tenure arrangements and agricultural productivity. In the present paper, we use data from farm surveys in Ghana, Kenya, and Rwanda to test the relationships through formal econometric modeling.

Conceptual Framework

The conceptual model to be tested is taken from Feder et al., which describes, for a study region in Thailand, the relationships between "secure ownership of land," as measured by the holding of a legal title, and land productivity. By substituting "privatized land rights" for "secure ownership of land," we can test Feder's model in the sub-Saharan African case. Farmers with more rights may have a higher probability of recouping the benefits from land improvements and thus will be more inclined to make medium- or long-term land improvements and to use complementary yield-increasing inputs. Because they imply a greater likelihood of repayment, improved land rights may also increase lender willingness to offer credit, leading to easier financing of improvements and inputs.

We can write these relationships in the form of a structural model, based on parcel-level observations (t) for each household:

$$C = f(\mathbf{X}^h, \mathbf{X}^t, S) \tag{1}$$

$$\mathbf{L}_t = f(\mathbf{X}^h, \mathbf{X}_t^p, \mathbf{X}^t, S_t, C) \tag{2}$$

$$\mathbf{I}_t = f(\mathbf{X}^h, \mathbf{X}_t^p, \mathbf{X}^v, S_t, C, \mathbf{L}_t) \tag{3}$$

$$Y_t = f(\mathbf{X}^h, \mathbf{X}_t^p, \mathbf{X}^v, \mathbf{L}_t, \mathbf{I}_t) \tag{4}$$

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In this model, we assume that land rights (S_i) are predetermined at the time of acquisition of the ith parcel, (an assumption discussed later). To simplify the presentation, we view S_i as purely exogenous, although this assumption is relaxed when estimating the model.

Equation (1) is a reduced-form equation describing the joint effect of supply- and demand-side factors on the household's use of credit. Dependent variable (C) is a household-level binary variable for the use of credit in the past year. It is hypothesized to depend on an aggregate measure (S) of the household's parcel-specific land rights variables (S_i), on village dummies ($\mathbf{X}^v$), and on household characteristic variables ($\mathbf{X}^h$), which capture differences in wealth, resource, and skill levels. Greater privatization of land rights is, *ceteris paribus*, hypothesized to lead to an increased supply and demand for credit and hence to greater use of credit.

Equation (2) states that land improvements ($\mathbf{L}_i$) made to the ith parcel since acquisition depend on rights held over that parcel (S_i), locational dummies ($\mathbf{X}^v$), household characteristics ($\mathbf{X}^h$), credit use (C), and parcel-specific characteristics ($\mathbf{X}_i^p$) including the stock of improvements made on the parcel prior to acquisition. Because C is defined as the incidence of credit use in the past year, it is used as a proxy in (2) for availability of credit at time of investment $\mathbf{L}_i$.

Equation (3) determines the past season's use of inputs ($\mathbf{I}_i$) on the ith parcel. Input use is hypothesized to be a function of the same variables as in the land improvements equation, plus land improvements ($\mathbf{L}_i$). We expect some types of land improvements to facilitate, or even complement, input use. For example, drainage or continuous composting of land may increase plant response to fertilizers.

Finally, equation (4) says that parcel yields (Y_i) in the past season are a function of household and parcel variables, location dummies, land improvements, and inputs.

The model's reduced-form equations are

$$(1') \qquad C = f(\mathbf{X}^h, \mathbf{X}^v, S)$$

$$(2') \qquad \mathbf{L}_i = g(\mathbf{X}^h, \mathbf{X}_i^p, \mathbf{X}^v, S_i)$$

$$(3') \qquad \mathbf{I}_i = g(\mathbf{X}^h, \mathbf{X}_i^p, \mathbf{X}^v, S_i)$$

$$(4') \qquad Y_i = g(\mathbf{X}^h, \mathbf{X}_i^p, \mathbf{X}^v, S_i)$$

Once estimated, direct tests can determine whether the land rights variable has a significant effect on the endogenous variables.

Data

To estimate this model, we undertook farm surveys in eight regions in Ghana, Kenya, and Rwanda, representing alternative population densities and agricultural commercialization. Within Ghana, we chose a land-scarce, highly commercialized, shallot-growing region (Anloga); a land-abundant, food-growing area (Ejura); and a land-abundant, cocoa-growing area (Wassa). Population density is 384 persons/sq. km. in Anloga but only 20–30 persons/sq. km. in Wassa and Ejura. All three Rwandan regions are densely populated (about 300 persons/sq. km.), each producing a similar crop mix (predominantly sorghum, sweet potatoes, beans, and coffee). However, commercial development is noticeably greatest in Ruhengeri and least in Butare. Within Kenya, two densely populated traditional African farming areas were chosen: the commercialized area of Kianjogu (coffee) and the maize-producing region of Madzu. Their population densities are 530 and 768 persons/sq. km., respectively. Each of the eight regions is dominated by agriculture and, while many households engage in some nonfarm activities, these rarely account for sizable shares of total family income.

Survey data were collected during 1987 and 1988. Between 100 and 150 households were surveyed (in two or three visits) in each of the Ghanaian and Kenyan regions and around 80 in each of the Rwandan areas. Among the variables measured were household characteristics (e.g., age, education, occupation of all members, number of regular workers, nonfarm income, wealth, use of credit), household head characteristics (e.g., farming experience, place of birth, local offices held), farm characteristics (e.g., size, number of parcels), and characteristics of each parcel (e.g., mode of acquisition, soil fertility, topography, distance from house, size, individual land rights, land improvements, type of document held, incidence of dispute and, for the last season, crops grown, inputs used, and output).

The majority of parcels in all regions are acquired through nonmarket channels such as inheritance, gift, government allocation, and appropriation (initial clearing and use of part of the pool of communal land). Inheritance is by far the most common method of land acquisition, while appropriation is becoming rare as unused land disappears. Land purchases are much less common, accounting for less than 18% of operated parcels in all regions except Madzu,

where the figure is 29%. Markets for leaseholds (fixed rentals, sharecropping arrangements, and pledges) are relatively weak in all regions except Anloga and Butare. Formal rural banking institutions also are poorly developed. Less than 13% of the farms received formal credit in 1987–88, except that in Anloga 37.4% received credit.

Defining Land Tenure Security

Unlike the Thai case studied by Feder et al., land security in sub-Saharan Africa is a more elusive concept than the simple holding of a title. A common feature of many of Africa's tenure systems is that all eligible members of local lineage or kinship groups have assured access to at least some land. But at the same time, full ownership rights over land traditionally reside with the community, and individuals have a more restricted set of use, exclusion, and transfer rights over the land they farm. Even in Kenya, where land has been widely titled for some time, vestiges of the traditional tenure systems still impinge on the freedom with which farmers can alienate land.

It follows that one is concerned less with overall land tenure security than with rights that the individual holds over specific land parcels. We hypothesize that farmers are more likely to improve parcels over which they have a long-term interest, both in terms of their rights to cultivate the land on a continuous basis and to dispose of the land in ways that provide adequate compensation for the value of any improvements. These features of land control are best captured by tenure measures based on the individual use and transfer rights that farmers have over land. To this end, we enumerated a full range of individual rights for each parcel operated by the sample households. They included (*i*) *use rights*—the right to grow annual crops for one or more years with and without choice of crop; grow perennial crops; make permanent improvements; collect fruits or firewood; cut trees; graze livestock; and be buried on the land; and (*ii*) *transfer rights*—the right to register the land; and lend, rent, mortgage, pledge, bequeath, give, or sell the land with and without approval from elders.

Formation of Land Rights Categories

If each use and transfer right is given equal weight, forming "bundles" of rights for individual parcels leads to an enormous number of combinations (over 200 in each of the Rwandan regions). Fortunately, because use rights do not vary much within regions, it is possible to simplify the analysis by forming three land rights categories based upon rights of transfer alone. Complete rights parcels are those which can be sold by the current operator Parcels which cannot be sold but can be given or bequeathed, usually to members of the same family or lineage, are classified as preferential transfer parcels. The remaining parcels, which may not be permanently transferred, are placed in a limited transfer category. For Butare, limited-transfer parcels were further subdivided into those with short-term and long-term use rights. These categories allow one to rank parcels from the most secure (complete rights) to the least secure (limited transfer). Cross-tabulations indicate that a greater percentage of parcels in the complete-rights category contain a more complete set of use and transfer rights than do parcels in other land rights categories.

Land rights are surprisingly privatized (table 1). Even the right to sell is prevalent, ranging from 8.5% of all parcels in Kianjogu to 81.5%

Table 1. Prevalence of Land Rights Across Study Regions

	GHANA			RWANDA			KENYA	
Land rights	Anloga	Wassa	Ejura	Ruhengeri	Butare	Gitarama	Madzu	Kianjogu
				(Percent)				
All parcels								
Limited transfer	52.4	6 0	21 0	15 5	36.7	21.1	26.2	23.6
Preferential transfer	2 1	29.1	6.6	3 1	16 5	21 3	6 3	67 9
Complete rights	45 4	64 9	72 4	81 5	46 7	57 6	67 5	8 5
Permanently held parcels								
No right to sell	23 3	29.7	17 5	2 4	28.2	22.4	30.9	91 3
Right to sell with approval	14 0	55 6	73.5	19.7	37 3	10 6	39 0	4.9
Right to sell without approval	62 7	14 7	9 0	77 8	34 5	67 0	30 1	3 9
Parcels held permanently	59 2	92.3	86 3	83 1	64.9	78 9	97 7	97.2

in Ruhengeri. Nevertheless, restrictions on transfer rights do exist in all regions, and they are even greater when the need to obtain family approval is taken into account.[1] For example in Ejura, only 9.0% of the permanently held parcels can be sold without approval, whereas 73.5% can be sold with approval. Although not shown in the table, there is considerable variation within most regions in land rights across parcels and often across parcels operated by the same farmer.

In defining land rights categories, we have chosen to ignore land titles. None of the sampled farmers in Ghana and Rwanda possessed a legal title for any parcel. In Kenya, most sampled farmers have the right to a current land title, but many have not bothered to update existing titles to reflect current ownership status. The considerable variation in the rights that farmers claim over their land in Kenya suggests that customary tenure still exerts a stronger influence than do land titles.[2]

Land Rights Variables in Econometric Model

In order to treat land rights as predetermined, we need to show that farmers cannot wilfully alter their rights. Land rights evolve slowly in response to population growth, agricultural commercialization, and changes in broader economic and political circumstances. But these changes affect land rights at the communal or regional level and are exogenously transmitted to the individual farmer. Some farmers' tenure situations may change while others do not, but many of these changes are generated by exogenous forces such as the death of a parent, attainment of adulthood or marriage of a son, or return of a relative from the city. However, farmers might be able to improve rights over individual parcels by investing in improvements. For example, planting trees or fencing land can enhance long-term claims to the land. Where this occurs, land rights and improvements must be specified as jointly determined.

The extent to which farmers can alter their rights cannot be tested directly because we did not measure land rights at acquisition time. But examination of the relationship between land rights categories and method of acquisition in each region showed that possession of specific land rights is, to a large extent, conditioned by acquisition method. For each acquisition method, there are no significant differences between land improvements made and land rights currently held. Nor are there any significant relationships between time since acquisition and land rights currently held. Thus, if land improvements do enhance security, the changes are too modest to explain any jump from one land rights category to another.

Even if land rights are predetermined, they need not behave as exogenous variables. If farmers can choose their rights at acquisition time, then land rights could be correlated with the error term in the model because of unobserved household or parcel effects. For example, only the poorer quality parcels might be rented, or only the more skilled and successful farmers might purchase land.

The most direct solution to this selection problem is first to regress land rights on other exogenous instruments and then use predicted land rights as an explanatory variable in (1′)–(4′). Unfortunately, we do not have adequate instruments with which to accomplish such a task. Instead, we take advantage of multiple parcel observations per household and use fixed-effects or error components regression techniques. This eliminates any correlation between land rights (or other parcel characteristics) and error terms which might emanate from unobserved household variables. However, it does not control for any unobserved parcel effects. Because we do not have multiple observations over time on individual parcels, we must rely on included parcel variables (such as soil fertility, topography, and distance from house) to capture both the observed and unobserved cross-parcel variation in quality.

Estimation and Results

In estimating (2′) to (4′) the land rights variables were entered as mutually exclusive dummies, with the most limited land rights category omitted from the regressions. Support for the tested hypotheses would be provided by positive and significant coefficients of the included land rights variables. In estimating (1′), where an aggregate household land rights variable is required, we used the percentage of operated area belonging to each of the land rights categories. Total operated area also was included to control for any size effects.

[1] Complete rights parcels were subdivided depending on whether or not the farmers needed to obtain family approval before selling.

[2] Because possession of a current title is a choice variable, it is not a relevant variable to include in a reduced-form model.

Land Rights and Credit

Credit use was too infrequent in most regions to warrant statistical analysis. Logit analysis of the incidence of credit use during the past year was made for Anloga and Wassa in Ghana, and Ruhengeri in Rwanda. In each case, a large number of household characteristic variables were included in the regressions.

We found no significant relationship in Wassa between possession of complete land rights and credit use. In Anloga, percentage of complete rights land was positively (and significantly) correlated with total credit use but not with formal credit use. This may suggest that more individualized land rights help to secure informal credit, an implication supported by the fact that nine of ten moneylender loans required land as collateral. In contrast, formal lenders did not often require land as collateral, lending instead under group guarantees. In Ruhengeri, a greater percentage of land with complete rights was negatively related to informal credit use. Because a large number of loans are used for food consumption, households with fewer land rights may be less able to meet their own food requirements.

Apart from Anloga, regression statistical fits were good. However, few of the household characteristic variables were significant, and unobserved household effects may be responsible for the significant land rights coefficients obtained in Wassa and Ruhengeri. We could not control for unobserved household effects because there was only one credit-use observation per household.

Land Rights and Input Use[3]

The input analysis was severely constrained by our inability to collect data on quantities of different inputs used. A binary analysis based on incidence of input use was impossible for those inputs used by nearly all farmers. Even where variation in input use did exist across farms, there usually was insufficient variation across land parcels within farms to allow control for household effects. Only in two cases could we successfully estimate input regressions, namely, for total cost/ha of nonlabor inputs in Anloga and Ejura. Despite reasonable OLS fits with significant F-statistics, land rights were not statistically significant in either case.

[3] In this and the following analyses, inadequate observations led us to drop 'preferential transfer' land in Anloga, Ruhengeri, and Madzu

Land Rights and Land Improvements

Land improvements were enumerated for all parcels except in Anloga, where only parcels that were both owned and operated were included. However, regressions could be estimated only for those land improvements exhibiting sufficient variation across households and parcels in a given region: improvements that show little or no variation will not be related to land rights. See the note to table 3 for the improvements analyzed by region.

Binary logit analysis was conducted on the occurrence of any (i.e., one or more) land improvements. For Wassa, Ruhengeri, Gitarama, and Butare, these regressions included household dummies. Household dummies could not be included elsewhere because either too many households had improved all their parcels in the same way, or there were too few parcels per household.

The strongest relationship between land rights and incidence of improvements was found in Rwanda (table 2). In each prefecture, the probability of making any of the listed improvements is positively associated with land rights. Additional binary regressions on individual improvements (not shown here) revealed that in Butare, short-term boundary marking and long-term improvements are each more likely on preferential transfer and complete rights parcels than on short-term use rights parcels. In Gitarama, boundary and long-term improvements are more common on preferential transfer and complete rights parcels. However, short-term improvements are not related to land rights. In Ruhengeri, the likelihood of making short-term or boundary improvements is positively related to complete rights parcels, but long-term improvements are not responsive to land rights.

More generally, the right to bequeath (membership in at least the preferential transfer category) is an important determinant of land improvements in Rwanda. Adding the right to sell does not significantly change the probability of making improvements beyond those in preferential transfer parcels. These results are not surprising, because almost all parcels in the least secure category are rented in or borrowed and tenants have the least incentive to invest.

In Madzu, Kenya, land rights are not significantly related to land improvements. In Kianjogu, Kenya, preferential transfer parcels are more likely to receive drainage or liming improvements than are limited-transfer parcels.

Ghanaian results are mixed. In Wassa, com-

Table 2. Summary of Land Improvement Regression Results[a]

	RWANDA			GHANA			KENYA	
	Butare	Ruhengeri	Gitarama	Anloga	Wassa	Ejura[b]	Madzu	Kianjogu
LAND RIGHTS								
Long-term use rights	−0 354							
Preferential transfer	2.459*		2 505		0.187			1.447*
Complete rights	2.421*	3.813*	3.284*			−0 058		
Complete rights,								
With approval				1 297*	2 180*		0 685	
Without approval				3 182*	0 233		0 561	
Goodness of fit								
% parcels improved	55.2	73 5	70 1	74.7	64 7	74 4	69.5	81 4
% observations correctly predicted[c]	85.4	86 7	89 5	85.1	75 9	76 4	73.7	82.5
Sample size	629	524	469	356	548	254	118	97

* = significant at a 5% level

[a] The results are from binary logit analyses that examine the probability of making any of the enumerated investments in each region. The following investments were considered (*i*) drainage and land excavation (forming raised beds) in Anloga, (*ii*) planting cocoa trees in Wassa, (*iii*) planting tree crops and destumping in Ejura, (*iv*) short-term improvements (continuous manuring or mulching), long-term improvements (trenching, planting grass strips, destumping, or planting trees) and boundary marking (green fencing) in Butare, Ruhengeri and Gitarama, (*v*) planting tree crops and terracing in Madzu (*vi*) and drainage and liming in Kianjogu

[b] All preferential transfer parcels were improved in Ejura, hence these parcels were dropped from the regression

[c] Based on Chi Square statistic, all regressions were significant at the 1% confidence level

Note: Other explanatory variables included in the regressions are as follows: (Parcel level) prior land improvements made, size, distance to house, soil fertility, slope, topographical location, and year since acquisition (the year since acquisition was also interacted with the land rights variables), (Household level) either dummy variables or the sex, farming experience, and origin of the household head

plete-rights-with-approval parcels are significantly related to planting tree crops. Among owned parcels in Anloga, complete-rights parcels (with or without approval) are more likely to be improved with drainage or excavation than are limited-transfer parcels. Finally, in Ejura there was no suggestion that land rights are related to the likelihood of destumping or tree crop improvement.

Multinomial logit analysis, allowing for interdependencies between improvements (but not for household effects), showed that land rights have less effect on choice of improvements than on the probability of undertaking an improvement. Type of improvement appears to be influenced most by village location and parcel characteristics such as existing improvements or distance from house. Only in two cases, Anloga and Gitarama, did more individual rights over land imply a greater probability of selecting more extensive bundles of improvements.

Land Rights and Yields

We employed subparcel (plot) data to analyze agricultural productivity if the parcels were not homogeneously cropped. Yields of different crops grown together were aggregated using median prices, so the dependent variable is the value of crop output per hectare. In order to control for unobserved household effects, fixed effects and error components models were employed. The latter has the advantage of allowing household characteristics to remain in the regression; these collapse into the household dummies in the fixed effects approach.

Because, except for Anloga, multiple crops are common in the study regions, some independent variables' yield effects may depend on cropping pattern. One can allow for this in two ways. The first is to perform separate regressions for each cropping pattern. Unfortunately, this permits relatively small sample sizes, so control of unobservable household effects becomes difficult. Because some variables do not depend on cropping pattern here, a better method is to stack separate cropping pattern yields into a single regression. Cropping pattern dummy variables were interacted with each variable in which the hypothesized effect on yield depends on cropping pattern. Examples of the latter include plot size, soil fertility, and distance to parcel.[4] No household or farm-level variables were considered crop-specific. We assumed a Cobb-Douglas form of the yield equation.

Yield regressions necessarily were restricted to crops and crop mixtures for which we had a sufficient number of output observations per region. We were unable to utilize the fixed effects model in some regions but the error components model is applied in every case.

The estimated OLS yield regressions are generally satisfactory in reduced-form equations, both in terms of R^2, statistical significance, and results for many of the included variables (tables 3 and 4). Nevertheless, no significant relationships are found between land rights and yield in any of our study regions. This is true in both the fixed effects and error component models.

These results are consistent with the absence of a strong relationship between land rights and input use. At first blush, however, they appear to be inconsistent with the significant and positive relationships found in all regions (except Ejura and Madzu) between land rights and some land improvements. In most cases, such inconsistency can be explained because the investments involved either are essential to the crops whose yields were analyzed (e.g., planting cocoa in Wassa, or excavating shallot beds in Anloga), or they are primarily land-conserving rather than yield-enhancing (e.g., draining in Anloga or trenching and grass planting in Rwanda).

Investment in continuous manuring or mulching in Rwanda, and liming in Kianjogu are more puzzling cases. These investments are significantly related to land rights and ought to have significant and positive yield effects. The yield equations may not have picked this up because we had only binary data on these investments and are unable to control for the amounts involved or the year in which they were last undertaken.

Conclusions

Rights that farmers hold over specific land parcels vary considerably in our study regions, and are in many cases surprisingly privatized. We have taken advantage of this variation to estimate parcel-level regressions relating land rights to input use, land-improving investments, and land productivity. At the farm level, we also estimated relationships between land rights and credit use.

With few exceptions, land rights were not found to be a significant factor in determining whether or not farmers made land-improving in-

[4] We ran some models with crop-specific land rights variables, but found no significant differences.

Table 3. Summary of Land Rights Results in Plot Yield Regressions[a]

Regression[b]	Long-term use rights	Preferential transfer	Complete rights	Complete rights with approval	Complete rights without approval	R^2	Sample size
Ghana							
Error Components Model							
Anloga				0 348	−0 012	0 91	273
Wassa				0.211	−0.106	0.81	265
Ejura		0 441	−0 82			0 83	243
Fixed Dummy Model							
Ejura		0 302	−0 196			0.68	243
Rwanda[c]							
Error Components Model							
Ruhengeri			0.321			0.53	200
Butare	0 191	−0 038	−0 163			0 60	306
Gitarama		0 499	−0 368			0.66	291
Fixed Dummy Model							
Ruhengeri			0 444			0 51	200
Butare	−0.325	0 138	−0 177			0.60	306
Gitarama		0.716	−0 418			0 67	291
Kenya							
Error Components Model							
Madzu				0 146	0 051	0 65	151
Kianjogu		0 127	0 337			0 84	304

[a] Parcels were subdivided into plots for this analysis if the cropping pattern was not homogenous

[b] All regressions are significant at the 1% confidence level (F test) No land rights variable is statistically significant at the 10 % level or better

[c] The Rwandan results are the combined effects of land rights and land rights interacted with the years-since-acquisition variable The interaction variable was included for Rwanda because of the large number of rentals and borrowings for which both years held and the set of rights tend to be highly collinear

Note The results reported here are for the following crops and inter-crop mixtures shallots in Anloga, cocoa, cocoa/maize, cocoa/plantain, and cocoa/kola in Wassa, maize, yam, and groundnut in Ejura, beans and sweet potato in Ruhengeri, coffee, sorghum, sweet potato, sorghum/sweet potato, and sorghum/other in Butare, coffee, sorghum, sweet potato, sorghum/maize, and sorghum/other in Gitarama, coffee, maize/beans, and maize/other in Madzu, and coffee, maize, maize/beans, and maize/other in Kianjogu

Table 4. Significant Variables in the Plot Yield Regressions[a,b]

	RWANDA			GHANA			KENYA	
	Butare	Ruhengeri	Gitarama	Anloga	Wassa	Ejura	Madzu	Kianjogu
Plot characteristics interacted with crop dummies	*Coffee* Size(−) Distance(+) *Sorghum* Size(−) Fertility(+) Wetland(−) Top hill(−) *Sweet potato* Size(−) Fertility(+) Wetland(+) Hillside(+) *Sorghum/ Sweet potato* *Size(−)* Size(−)	*Beans* Size(−) Hillside(−) *Sweet potato* Size(−) Wetland(−)	*Coffee* Size(−) Fertility(+) Top hill(+) *Sorghum* Size(−) Distance(+) Slope(+) Top hill(−) *Sweet potato* Size(−) *Sorghum/maize* Size(−) Fertility(+) *Sorghum/other* Size(−) Slope(+)		*Cocoa* Size(−) Years held (+) *Cocoa/maize* Size(−) Distance(+) Crop dummy(+) *Cocoa/plantain* Size(−) Crop dummy(+) *Cocoa/kola* Years held(+)	*Maize* Size(−) *Yam* Size(−) Distance(−) Crop dummy(+) *Groundnut* Size(−) Crop dummy(−)	*Coffee* Size(−) *Maize/beans* Size(−) Fertility(+) *Maize/other* Size(−)	*Coffee* Size(−) *Maize* Size(−) Crop dummy(−) *Maize/beans* Size(−) Crop dummy(−) *Maize/other* Size(−) Crop dummy(−)
Other variables[c]		Prior long-term improvements(+) Village dummies	Written land receipt(+) Prior boundary improvement (−)	Plot Size(−) Distance(+) Prior drainage & excavation(−) Village dummies	Wealth(+) Village dummies			Farm size(+)

[a] Significance defined at the 10% confidence level or better (2−tail tests) (Signs of coefficients in parentheses)
[b] The regression results are from an error components model
[c] The coefficients of the land rights variables, and the statistical fit of the regressions are reported in table 3
Note The following explanatory variables were included in the regressions: (Parcel level) prior land improvements made, size of parcel, distance to house, soil fertility, slope of parcel, topographical location, cropping pattern (cropping pattern was interacted with many of the above variables), (Household level) farm size, number of parcels, household wealth per hectare, non−farm income per capita, number of adult male equivalents per hectare, and the farming experience, gender, occupation, residency status, and education of the household head, and village location dummies

vestments or used yield-enhancing inputs. The most pronounced relationships were found in Rwanda, where the right to bequeath is a significant determinant of some types of land improvements. This result is unsurprising, because parcels that cannot be bequeathed are mostly rented or borrowed under short-term arrangements, and the tenant has little incentive to invest. Use of formal credit does not appear to be significantly related to land rights.

A direct test of whether Africa's indigenous land rights systems are a constraint on productivity is based here on reduced-form yield equations. Despite generally satisfactory statistical fits in our yield regressions, land rights were not significantly related to yields in any study region. These results suggest that either all current types of land tenure are equally restrictive in spite of their wide variations in form, or more likely that there are other more binding constraints on agricultural productivity (such as lack of improved technologies or inadequate access to credit).

Our study provides little support for ambitious land registration and titling programs at the current time. In principle, such programs could increase productivity by providing more privatized and secure land rights in situations where their absence is a deterrent to land intensification decisions by farmers and lenders. However, the Kenyan data show that even in regions where all land has been titled, customary restrictions on land rights still prevail and it is not clear that new rights have been created. Our econometric results also suggest that even if land rights could be changed, they may not affect productivity if there are more binding constraints. Land titling may encourage more bank lending to agriculture, but the virtual absence in the study regions of formal lending or of any variation in land titling prevented us from testing this hypothesis. Anecdotal evidence suggests there are constraints more serious than land titling to the development of efficient and financially viable credit institutions in these regions.

It would be dangerous to extrapolate our results too broadly to other regions in Africa. Our study covered areas of rainfed agriculture only. Questions remain about the suitability of indigenous land rights for irrigated farming, extensive pastoral and livestock systems, and communal forestry, even within the countries we studied.

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