Rural Sociology 62(3), 1997, pp. 295–314

Fruits of Their Labors: Gender, Property Rights, and Tree Planting in Two Zimbabwe Villages[1]

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ABSTRACT An analysis of tree planting by women and men in two Zimbabwe villages demonstrates that women are significantly less likely than men to plant trees on homestead land where the security of their duration of tenure is uncertain due to the likelihood of change in marital status. However, men and women are equally likely to plant trees in community woodlots where the duration of their tenure is secure if they remain village residents. These findings demonstrate the importance of attention to gendered security of tenure at the sub-household level.

Introduction

The relationship between security of tenure and improvements to agricultural land has been a long-standing focus of scholarly and policy debate. Tree planting has become a matter of particular interest in these debates, as it has been identified as part of the solution to problems ranging from household dietary deficits to local soil erosion to global warming. While improvements to, and investments in, land (including tree planting) are generally considered to depend on secure tenure under which the farmer is confident of reaping the returns from investment (Brokensha and Castro 1984; Bruce 1986; Bruce and Fortmann 1989; Dewees 1995a; Feder et al. 1988), there has been relatively little empirical work on what constitutes secure tenure and whose security of tenure matters. An exception is a compilation of studies in seven countries which explores the capacity of customary systems to provide secure tenure. In these studies, the authors disaggregate security of tenure into three components: breadth (the composition of rights), duration (the length of time a right is legally valid), and assurance (the certainty with which a right is held) (Place et al. 1994:20). In this article, we build on Place et al.'s insights in conducting an empirical examination of the security of duration of tenure.

[1] The fieldwork for this study was conducted by Louise Fortmann and Nontokozo Nabane. We would like to acknowledge the invaluable assistance and/or helpful comments of R.B. Drummond, Marshall Murphree, James Murombedzi, Calvin Nhira, Frank Matose, Jeanette Clark, Newton Spicer, Julie Stewart, Gary Casterline, Jeff Perloff, David Zilberman, Emery Roe, Peter Berck, Jinhua Zhao, Gillian Hart, and anonymous reviewers.

In many parts of Africa, security of duration of tenure is a matter of particular concern for women. While security of tenure is often treated as a household characteristic, and is so treated in all but one of the seven African case studies (Bruce and Migot-Adholla 1994), even in households with secure tenure, women's property rights are often insecure and, in particular, the duration of their rights is subject to extreme uncertainty (Akwabi-Ameryew 1996; Davison 1988; Golan 1994; Wengi 1996). Since women constitute the majority of able bodied workers in many rural areas, their insecurity of tenure could have significant adverse effects on investment in agricultural production, including tree planting. Unfortunately, the studies in Bruce and Migot-Adholla (1994) pay only superficial attention to the question of gender (Place et al. 1994:37), and studies of tree planting rarely address the issue of the effect of women's security of tenure: for example, DeWees' (1995b) otherwise admirable study of tree planting in Malawi.

This study explores the effect of insecure duration of tenure by analyzing gender differences in tree planting in two rural Zimbabwean villages. In contrast to investments in arable crops, which can be recovered at the end of a single cropping season, the returns to tree planting frequently occur a number of years after planting and, in the case of fruit, continue over a span of years. Thus, willingness to invest in tree planting is a particularly suitable indicator of the effects of security of tenure, defined in terms of duration.

Security of tenure and gender in rural Zimbabwe

Most residents of rural Zimbabwe live in the Communal Areas where the land on which people reside, farm, and graze their cattle is vested in the state rather than in the communities or households themselves. There is informal evidence of a sense of uncertainty among many residents of the Communal Areas about the security of their tenure. For example, in conducting our survey, we encountered people who feared that their answers could lead to confiscation of their fields by the government. These fears arise not only out of memory of the horrors of colonial experiences but also from post-independence land confiscation for development projects and from conflicting claims by the locality and the state (Derman 1990; Mauchaza 1991; Mutambara 1990; *Parade* 1990).

These general uncertainties about security of tenure in the Communal Areas might be expected to have adverse effects on tree planting, management, and use by anyone. Additional uncertainties affect women. In both recorded tradition and in present practice, women's right to property has been limited at best, particularly in the Communal Areas where customary law applies (Armstrong et al. 1993; ZWRCN 1994). Women acquire access to land through their fathers, husbands, and brothers (Bruce 1990; Gaidzwana, 1988), and girls have no rights of inheritance from their parents (Maboreke 1990). Moreover, for women, special uncertainties about the duration of tenure arise from the possibility of change in marital status. A divorced woman in the Communal Areas has no rights to her husband's land, including trees she herself has planted and tended, not even the right to live in a home that she herself has built and furnished (Maboreke 1990).[2] Further, widows in the Communal Areas have no right to inherit their husbands' property, including trees that they themselves have planted and tended, although they do have rights against the male heir (Bruce 1990). While widows may be granted informal rights to products from trees which they have planted, they have no legal rights to them. In short, in terms of duration, women have less secure tenure than do men.

Tree planting in the Communal Areas occurs in three kinds of sites: homestead land, individual woodlots, and community woodlots. Homestead land immediately around the family's dwellings is often, but not always, enclosed by a fence or a hedge and is controlled by the household. Fruit and medicinal trees are most frequently planted in this space.[3] Household woodlots are also controlled by the household and may be adjacent to the homestead (in which case, they may be enclosed) or in an area designated for such use. They are generally planted with eucalyptus for use as poles, not as firewood.[4] Trees on homesteads and woodlots are legally held in conjunction with the land and are inherited by the heir. In general, the exclusive right of the homestead residents to the fruit of trees planted in the homestead appears to be recognized and honored. Within the homestead itself, there is often recognition of special rights accruing to the tree planter, including women. However, the husband has a legal right to the agricultural produce produced by his wife (Ncube 1991). Hence, while actual practice may vary from household to household, the legal position would seem to be that any tree products produced by the wife are the property of her husband. Community woodlots are planted, usually with eucalyptus, in areas set aside for this purpose, and these areas are governed by a variety of community-level arrangements. In the event of divorce, a woman who participated in planting the community woodlot generally retains her rights to use woodlot trees as long as she continues to reside in the community.

[2] In the court case which formalized this rule, the wife, who lost everything, had worked on and developed the homestead during 23 years of marriage (Ncube 1991).

[3] With the exception of a minuscule number of idiosyncratic individuals, rural people plant trees for utilitarian reasons. However, existing trees are protected for a variety of reasons.

[4] Women do not favor eucalyptus as firewood because it smokes and does not have desirable flame characteristics.

The prevailing theory suggests that farmers would be unlikely to plant trees on land where they have an insecure duration of tenure. In the Communal Areas of Zimbabwe, married men and women experience two components of tenure—breadth and assurance of tenure—in essentially the same way. Both have the breadth of their tenure restricted by national laws that forbid commercial sale of land and other natural resources in the Communal Areas. Both experience the same lack of assurance stemming from the (currently remote) possibility that the state will confiscate their land. The third component, duration, is experienced differentially by women and men. Because of uncertainties about their husband's longevity and/or the duration of his commitment to their marriage, women experience considerable insecurity of duration of tenure for property that is contingent upon the marriage. Put simply, they do not know how long their marriage will last and, therefore, they do not know how long their rights to land and trees will last. If the security of tenure hypothesis that tree planting depends on security of tenure is correct, we would expect women to be less likely than men to plant trees on household land (where their duration of tenure is insecure) and equally likely to plant in communal woodlots (where their duration of tenure is secure as long as they remain in the village).

Because of well-documented differences in the economic/livelihood strategies of women in different economic circumstances (Deere 1982; Fortmann 1984; Leach 1995), we consider the effects of household wealth as well as those of gender.

Methods

Data were collected in two villages in central Zimbabwe using a geographically stratified random sample survey of 27 percent of the households in each village. The survey was conducted in Shona by a research team of local residents. Whenever possible, both the senior man and woman in the household were interviewed separately by same-gender researchers. However, as is typical of southern Africa, because of the large number of men working and living outside the village and the prevalence of female-headed households, the final sample of 154 consisted of 48 men and 106 women. Key informant interviews were conducted with village leaders, elderly villagers, and all divorcees. Data were collected on the following variables:[5]

Tree planting. Respondents were asked who planted each currently living tree in the homestead and whether they personally

[5] Detailed descriptions of the variables are in Appendix A. Despite any sound theoretical justification, some people believe that education is important in the decision to plant trees. Education had neither direct or interaction effects in our regressions, although these results are not reported here.

had a woodlot or had participated in planting trees in the community woodlot. A positive response to "Planted" indicates that the respondent had personally planted at least one tree in the homestead. A positive response to "Woodlot" indicates that the respondent had personally planted at least one tree in the household woodlot. A positive response to "Community Wood" indicates that a respondent had personally planted at least one tree in the community woodlot.

Wealth Index. The village research team ranked each household on a scale of 0 to 5, based on household assets and the security of access to those assets (see Appendix A).

Data were analyzed using logit models and truncated negative binomial models. The latter were used to analyze numbers of trees planted. For reasons described below, the model separates those who planted from those who did not. The truncated negative binomial is appropriate for this type of analysis because 1) it is a count data model, and our independent variable is a nonnegative, discrete count; and 2) the estimators are based on a count data distribution truncated at 0.

Ideally, we would have a dummy variable for each category, but this sacrifices degrees of freedom. Therefore, the six wealth categories were aggregated into three dummy variables: Poorest for the two poorest categories, Moderate Income for the two middle categories, and High Income for the two richest categories.

Study sites

Rain-fed cultivation of maize, groundnuts, and other crops is practiced by both men and women in both study villages. Men are likely to work as wage laborers in urban areas, while women manage the rural homestead, including doing all the farming. Members of some poorer households also work as wage laborers for richer households. Planted and wild trees provide poles, fuel wood, fruit, green manure, medicine, rope, wood for small utensils, browse, edible insects, shade, religious sites, and a host of other goods and services. Farmers in both villages use regular bus service to the capital city to sell fruit commercially. Planted trees are most often exotics such as eucalyptus, orange, lemon, guava, and mango. Both women and men plant trees in both villages, and there are no cultural prescriptions against women's tree planting (Chavangi et al. 1988). Nor is physical strength an issue—the physical labor involved in planting a tree (or even several) is no more arduous than the back-breaking labor of planting a crop of groundnuts, a woman's task. All households hold land under the same tenurial arrangements; thus, the major variation in security of tenure was between women and men.

Findings

Who plants in the homestead?

While 56 percent of the respondents had planted at least one tree in the homestead, only 44 percent of the women planted trees in their homestead in contrast to 83 percent of the men. To analyze homestead tree planting, we used logit models, as they are appropriate for situations in which individuals must make a choice between two options—in this case, to plant or not plant—and they can be used to estimate probabilities—in this case, the probability that a person will plant a tree.

As can be seen in Table 1, women are significantly less likely than men to plant trees in the homestead. The marginal effects are as follows.[6] Taking the average value of each variable over the entire sample, the predicted probability of planting a tree is 58 percent with all other variables held at their average. With all other variables held at their mean, men had an 83 percent probability of planting a tree in the homestead while the probability for women was only 43 percent. Wealth was not significant at the .05 level.[7] That is, poor and mid-level farmers were as likely to have planted at least one tree as the wealthy, although they are not necessarily planting for the same reasons. The highly significant coefficient for the intercept indicates that poor men (that is, Gender = Moderate Income = High Income = 0) have a positive (and highly significant) probability of planting a tree. From this model, we conclude that gender plays a more important role than wealth in the decision to plant on homestead property.

The likelihood ratio test compares a specified model to the null hypothesis that the coefficient values on the independent variables equal zero; that is, the explanatory variables other than the intercept have no impact on the probability of planting at least one tree. The statistic for this estimation is 27, significant at the .005 level (distributed as a chi-squared), which indicates that the model is highly significant.

A nested likelihood ratio test between the model and the model plus interaction effects for Gender/Moderate Income (Gender/Moderate Income Interaction) and Gender/High Income (Gender/High Income Interaction) resulted in a likelihood ratio of .44, which is statistically insignificant. Therefore, the nested test fails to reject the null hypothesis that the differential effects of the gender

[6] The "marginal effects" refer to the change in probability given by the dependent variable with a change in the independent variable, with the other independent variables held constant.

[7] High Income has large marginal effects when we change it to zero or one from its mean value of .07. This suggests that High Income has some effect on homestead planting. However, because it is insignificant at the .05 level in the logit regression, we do not have much confidence in this apparent effect.

Table 1. Logit equation for tree planting in homestead

Variable	Coefficient Value
Intercept	1.39** (3.20)
Gender	–1.91*** (–4.379)
Moderate Income	0.26 (0.70)
High Income	1.58 (1.85)

** Significant at the .01 level.
*** Significant at the .001 level.
Log likelihood statistic: 27.019
Nested log likelihood (gender/wealth interaction):.442
Nested log likelihood (dummy variable for village):1.771
t-statistics are in parentheses.

and wealth interaction equal zero. The same is true for the model adding a dummy variable for village. The dummy variable representing the second group of villages sampled was statistically insignificant.[8] The "50 percent rule" leads to a fairly good prediction rate for the model: if we claim that any individual with a predicted probability of less than 50 percent will not plant a tree and those over 50 percent will, our model correctly predicted 67 percent of the actual observations (103/154). These findings support the security of tenure hypothesis.

Data on divorcees

In this section, we supplement our models with interview data from all female divorcees in our field sites. All of the 18 divorcees interviewed indicated that they had lost the rights they had to the trees they had planted during their marriage. The women said they regretted having planted any trees at all. Seven of the 18 indicated that they had been married in the same community where they have built their "new" (own) homes. Even though their former husbands' homesteads are nearby, these women do not have rights to, or control over, trees that they planted. Some expressed bitterness at seeing their former husband's new wife picking fruit from trees which they themselves had planted and are no longer permitted to use. These women were quite clear that, if they were to marry again, they would not plant any trees, in case they divorced again and once again lost everything they had planted. These findings support the security of tenure hypothesis.

[8] Neither the addition of the interaction terms nor the removal of Moderate Income from the basic model dramatically altered the estimated values of the basic model, so the results exhibit some degree of robustness.

Homestead tree planting—who planted how many trees?

A related but separate question is how many trees an individual plants. The decision to plant more than one tree may be different from the decision whether to plant any tree at all. Therefore, we separate the sample into a full sample and a sample of only those individuals who planted one or more trees.

These data show the effect of the interaction of gender and wealth. Men planted an average of 12.56 trees while women planted an average of 9.88. There is very little difference between the average number of trees planted by the poorest men (4.47) and women (6.25), both of whom are planting for subsistence and perhaps some market sales. Within this category, it is clearly wealth, not gender, that matters. Among men, there is a clear linear relationship between wealth and number of trees planted (Poorest = 4.47, Moderate Income = 15.94, High Income = 28.50). The greater the wealth, the greater the ability to engage in commercial production, the greater is the average number of trees planted. Among women, however, this relationship does not hold. Among those who planted, rich women plant the least (6.2) out of all the gender/wealth categories except for men in the lowest wealth group. It is likely that this reflects both women's tenurial insecurity and the differing livelihood possibilities by wealth category. Assuming she owns her own cash, any woman, rich or poor, who invests heavily in tree planting is vulnerable to losing it all under the prevailing husband-take-all rules of divorce or upon the death of her husband. Rich women have less risky means of making money, such as producing annual crops for sale, beer brewing, and handicraft sales. Thus, while it makes sense to plant some trees for subsistence needs and for small-scale commercial sales, large-scale plantings involve a substantial risk. It is also the case that commercial production (whether of arable crops or of trees) is more likely to be considered men's work. Finally, male household heads may simply be unwilling to dedicate the necessary area of land to their wives' tree plantations.

The results for the non-truncated and the truncated negative binomial models are displayed in Table 2 for the set of observations of individuals and in Table 3 for a set that excludes the three farmers with plantations of 90 or more trees. While results for both the non-truncated and the truncated samples are shown, we are concerned only with the truncated version which tests the hypothesis that gender differences exist among those individuals who planted trees. The truncated negative binomial corrects for the sample selection bias created by dropping the zero observations. See Cameron and Trivedi (1996), and Creel and Loomis (1990).

All respondents. Both the negative binomial and the truncated negative binomial regressions on the full dataset provide excellent fits of the data when testing for the direct effect of the gender and wealth terms.[9] The likelihood ratios for all models are highly significant. In the first model, Gender is negative and significant, and Moderate Income is positive and significant, as expected. The negative binomial model is based on the Poisson regression model but adds an extra parameter α which accounts for the difference between the mean and variance of the data. The α parameter is significant in this estimation, providing evidence that the negative binomial model is a more suitable estimation procedure than a Poisson model. Gender is not significant in the truncated version while High Income becomes significant. That is, wealth has a greater effect on the number of trees planted than does gender. The α parameter is not significantly different from zero, implying that the mean and variance in this subsample are equal. However, the likelihood test statistic comparing the truncated Poisson model and truncated negative binomial model is significant at the .01 level and supports the application of the negative binomial formulation.[10]

When interaction terms and a dummy variable for village are added, the truncated version of the extended model shows that only Moderate Income has a significant effect on tree planting. Moderate Income is positive and significant in almost all the negative binomial models tested. Gender is not significant, most likely because the interaction of gender and wealth, while negative and insignificant at the .05 level, reduces the direct effect of Gender. The interaction terms have negative signs; however, both are weak influences in the model. The α parameter is not significant, but the likelihood test statistic between the truncated Poisson model and truncated negative binomial model is significant at the .05 level, supporting the claim that the negative binomial formulation provides a better fit than the Poisson model. Comparing predicted and actual zero observations also measures the reliability of the negative binomial model. In our case, the prediction of zero observations in the negative binomial estimation without truncation falls fairly close to the actual number of zero counts, when we account for gender, wealth, interaction of gender and wealth, and the dummy variable for village. Actual zero observations are 46.3 percent, and predicted zeroes are 44.9 percent. Therefore, we consider the model to be reliable.

Excluding plantation farmers. The plantation farmers, those who planted 90 or more trees, fell into the Moderate Income (a man

[9] For a fuller explanation, see Appendix B.

[10] Poisson regression results are available from the authors upon request.

Table 2. Coefficient values for negative binomial regressions

Variable	Neg. Bin. N = 147	Truncated NegBin N = 147	Neg. Bin. N = 147	Truncated NegBin N = 147
Constant	1.49*	1.09*	1.21*	0.81
	(3.62)	(2.24)	(2.18)	(1.75)
Gender	–0.84*	–0.19	–0.64	0.34
	(–2.27)	(–0.62)	(–1.00)	(0.59)
Moderate Income	1.02*	1.21*	1.32*	1.63*
	(3.48)	(3.56)	(1.96)	(3.82)
High Income	1.34	1.33*	1.57	1.90
	(1.69)	(2.43)	(0.91)	(1.87)
Gender/Moderate Income Interaction			–0.69	–0.96
			(–0.88)	(–1.35)
Gender/High Income Interaction			–1.14	–2.10
			(–0.54)	(–1.60)
Village 2			0.68*	0.44
			(1.95)	(0.98)
Alpha	3.69*	3.20	3.54*	2.67
	(7.25)	(1.60)	(6.92)	(1.77)
LR statistic	1756	1108	1704	1048

* Significant at the .05 level.
t-statistics are in parentheses.

and a woman) and High Income (one man) categories. Gender is not significant in the model excluding plantation farmers (Table 3). Since High Income had the fewest number of observations, dropping the plantation farmer causes High Income to lose any effect. However, Moderate Income is positive and significant in the truncated version. That is, when we consider only the non-plantation tree planters, women did not plant significantly fewer trees than men, whereas a medium level of wealth consistently raises a person's likelihood of planting more trees. The α parameters are positive and significant, verifying that the negative binomial is a better fit than the Poisson regression model.

All the above models have likelihood ratio statistics that are significant at the .05 level, allowing us to reject the null hypothesis that our model adds no significant explanatory power to the number of trees individuals in our sample planted. Further, all the negative binomial models are significantly different from their Poisson counterpart, as verified by a log-likelihood test between the Poisson and negative binomial fitted models.

These findings are consistent with research which has shown that the limitations imposed by socio-economic status overwhelm gender in livelihood decisions (Deere 1982; Fortmann 1984; Leach

Table 3. Coefficient values for negative binomial regressions, regressions, excluding y > 90

Variable	Neg. Bin. N = 144	Truncated Neg. Bin. N = 144	Neg. Bin. N = 144	Truncated Neg. Bin. N = 144
Constant	1.36*	1.37*	1.24*	1.20*
	(3.21)	(5.14)	(2.49)	(4.23)
Gender	−0.65	0.05	0.05x	0.43
	(−1.51)	(0.18)	(−0.98)	(1.09)
Moderate Income	0.56	0.60**	0.75	0.90*
	(1.77)	(2.29)	(0.97)	(2.28)
High Income	0.72	0.26	0.63	0.56
	(0.87)	(0.49)	(0.06)	(0.10)
Gender/Moderate Income Interaction			−0.35	−0.57
			(−0.42)	(−1.06)
Gender/High Income Interaction			−0.02	−0.56
			(−0.00)	(−0.10)
Village 2			0.29	−0.03
			(0.84)	(−0.08)
Alpha	3.07*	1.20**	3.04*	1.17*
	(6.35)	(2.42)	(6.39)	(2.45)
LR statistic	700	264	696	258

* Significant at the .05 level.
** Significant at the .01 level.
t-statistics are in parentheses.

1994). That is, poor women behave more like poor men than like rich women. We have seen that gender affects the decision to plant; however, once a woman has decided to take the risk of planting trees, she behaves consistent with her wealth category. Rich women are an exception, as noted above. While bearing in mind the problems of the small sample size for this wealth category, our findings suggest that, for the reasons discussed above, rich women have different tree planting strategies than do rich men.

These findings reflect the limitations and possibilities associated with each wealth category. There is a clear limit to how much fruit or medicine a single household can consume. Therefore, planting solely for domestic consumption is likely to be small numbers of trees. Commercial production, in contrast, requires planting multiple trees, either for the original stock or to provide replacements for older trees going out of production. Commercial production requires access to enough capital to purchase seedlings and the termaticides deemed necessary to keep them alive; control over sufficient labor to water and protect them; and access to transportation to get produce to the urban market—all more likely to be associated with wealthier households. The evidence suggests that, among those who planted, mid-level wealth exerts a significant positive effect on the number of trees a person will plant. Since mid-level farmers are likely to have access to the resources to buy, plant, and care for seedlings and the land on which to plant them, but they lack access to capital intensive income strategies, trees are likely to be a good option for them. In contrast, poor farmers are unlikely to have sufficient resources to engage in large-scale commercial production, while the wealthiest farmers may have more lucrative options for investment.

Planting a personal woodlot

While their tenure is similar to homesteads, we would expect personal woodlots to be planted disproportionately by men, since obtaining and using poles and, in particular, the commercial production of poles, are often male activities.

Again, we use logit models to analyze our data. Table 4 shows the results of the logit formulation of the hypothesis for both personal and community woodlot planting. As expected, gender is highly significant and negative, indicating that, in this sample, women are much less likely to plant a personal woodlot. Moderate Income is significant and positive, while High Income does not add explanatory power to the model. Moderate Income is positive and significant because those in the lower wealth category do not have the land or income to buy the inputs needed to maintain a personal woodlot, while the higher wealth category engages in other activities and may be able to purchase wood if necessary.

The dummy variable for village suggests the importance of support services in woodlot forestry. Village 2 is negative and significant, meaning that living in the second village results in less likelihood of planting woodlots. This reflects the fact that the first village had an energetic local leader who actively promoted woodlot planting and an extension agent from whom eucalyptus seedlings could readily be obtained. Thus, village level institutions which facilitate the implementation of individual decisions affect certain kinds of tree planting. However, this does not affect homestead planting because extension workers are less likely to provide fruit seedlings.

The likelihood ratio of the model without the dummy variable for village is 21.42, and this is significant at the .005 level. The nested log likelihood ratio is 14.98, significant at the .01 level, which reflects the explanatory power that Village 2 adds to the basic model. The logit estimation with the interaction effects of gender and wealth resulted in insignificant statistics for these variables and did not change the basic results. The nested log likelihood ratio test comparing the difference between the model shown and the same model adding interaction effects gave an insignificant score. The 50 percent rule shows that, comparing fitted with actual values, the model correctly predicted 73 percent of the responses.

Table 4. Logit equations for woodlot planting

Variable	Value (Personal Woodlot)	Value (Community Woodlot)
Intercept	0.03	−1.27**
	(0.07)	(−3.01)
Gender	−1.53**	−0.77
	(−3.91)	(−1.89)
Moderate Income	0.99**	1.63**
	(2.28)	(3.80)
High Income	1.38	1.79**
	(1.80)	(2.39)
Village 2	−1.16**	1.05**
	(−2.66)	(2.70)

* Significant at the .05 level.
** Significant at the .01 level.
t-statistics are in parentheses.

Personal Woodlots

Likelihood statistic without dummy variable for village: 21.42
Nested likelihood statistic with dummy variable for village: 14.98
Nested likelihood statistic with interaction terms, compared to regression with dummy variable for village: 0.33

Community Woodlots

Likelihood statistic: 27.27
Nested log likelihood with dummy variable for village: 14.85
Nested log likelihood with interaction terms, compared to regression with dummy variable for village: 0.58

For the model's marginal effects, the average probability of an individual planting a woodlot was 31 percent. With other variables held at their mean, women had a 22 percent probability of planting a woodlot compared to 57 percent for men, giving a spread of 35 percent between men and women. Living in the second village lowered this probability to 19 percent. The spread in probability of planting between groups in the mid-level wealth group and not being in that group was 21 percentage points.

Planting in the community woodlot

Extension workers have encouraged villagers to plant community woodlots of eucalyptus. The governance of access to these woodlots varies by community. The existence of a woodlot to some extent reflects both the centrality of the village (is this a place which extension workers visit?) and its ability to organize to capture the resources controlled by extension agents.

The data show clear wealth effects. The ten Poorest respondents participated in the planting, but none actually used the community woodlot, and only 20 percent of the 50 Moderate Income respondents who planted in the community woodlot used its trees. Seven of the eleven High Income respondents participated in planting, and 36 percent of the seven actually used the community woodlot. In contrast, the data do not demonstrate gender effects. Community woodlot planting was done by 41 percent of the women and 50 percent of the men in the sample. This relative equality may reflect the disproportionate number of women in the able bodied population. It may also be the result of a perceived higher valuation of men's time, so that men's time is allocated to personal holdings or outside jobs, and women's time is allocated to meeting the household obligation to support a community project.

Since Community Wood represents a binary choice, we again apply the standard logit model to estimate the effects of the independent variables. Table 4 displays the results of the model, and Gender is insignificant. The fact that women participate in planting in the community woodlot where they have assured access to community trees (that is, secure duration of tenure) supports the security of tenure hypothesis. However, since we cannot distinguish women who are family emissaries from women who are planting on their own behalf, we cannot speak with complete assurance on this point.

Moderate Income and High Income are positive and significant, reflecting the ability of higher wealth groups to contribute time and resources to planting in the community project as well as a tendency in some rural areas for the community woodlots to constitute extensions of the private holdings of the wealthier or more influential families of the community. This finding may reflect constraints among the lowest wealth category in investing time or other inputs into community projects. Village 2 is significant, probably reflecting the influence of a resident extension worker.

The likelihood ratio test statistic is 27.27, significant at the .01 level. Adding the dummy variable for village to the model raised the model's explanatory power, as seen by the likelihood ratio, 14.85, significant at the .01 level. The interaction of wealth and gender were added to the model, but they were insignificant and did not alter the model shown. The nested log likelihood ratio test statistic was insignificant (.58). According to the 50 percent rule, the model predicted the correct response 73 percent of the time.

Translating the estimations into probabilities reveals that the average probability of planting in the community project is 41 percent. The independent variable with the largest marginal effect is High Income. With all other variables held at their mean value for the sample, membership in the high-wealth category increases the probability of a positive response to 79 percent. Not being in this group drops the probability to 38 percent, leading to a 41 percent spread. For those in Moderate Income, the spread in probabilities is 37 percent. However, the Moderate Income is more evenly distributed (mean = .56) than the High Income (mean = .07). Therefore, the marginal effects may be more meaningful for Moderate Income than for High Income when evaluated at the mean.

Wealth affects the decision to participate in the community woodlot planting for several reasons. Wealth facilitates the ability to contribute resources beyond private plots, particularly time. The wealthier also tend to exert more control over common property resources and have greater incentive to plant in these areas, knowing that the fruits of their labors will be directly appropriated by them. Finally, status or group norms may confer some sense of leadership or responsibility on wealthier groups. They participate to fulfill their responsibility or to maintain status.

Discussion

Our data show that, as predicted, women are less likely than men to plant trees in spaces controlled by the household where the duration of their tenure is insecure, but they are equally likely to plant trees in community woodlots where the duration of their tenure is more secure, or they are family emissaries to community projects. With the exception of the wealthiest women, women who plant trees do not plant fewer trees than men. Can we confidently ascribe the difference in the likelihood of planting to insecurity of tenure? We have no direct statistical proof, but we do have evidence in comments by divorcees. Further, we can think of no persuasive alternative explanations. As noted above, cultural prescriptions, physical strength, division of labor, and education are not explanatory. The most likely systematic difference between women and men that could influence tree planting is the difference in security of tenure.

Our findings suggest that differences in security of duration of tenure are likely to make a difference in other long-term investments in agriculture. We would not, however, expect them to affect short-term investments such as commercial fertilizers for application on annual crops.

Many questions remain unanswered. Is there a threshold effect such that secure tenure for varying durations will influence behavior differently? What processes do women use to compensate for or increase their security of tenure (cf. Leach 1994; Moore 1993)? How does insecurity of breadth or assurance of tenure affect short-term and long-term behavior? What are the cumulative effects of varying levels of insecurity in each of the three components of tenure on short and long-term behavior? Clearly, in-depth field studies are called for to provide nuanced understandings of the effects of security of tenure. However, even our present broad brush findings make it clear that women's property rights are of practical importance and that scholars, policy makers, and practitioners alike need to consider gendered security of tenure at the sub-household level.

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Appendix A: Description of variables

Dependent variables

Planted: a dummy variable for planting a tree = 1 if the individual planted a currently living tree in the homestead (*musha*), 0 otherwise. Note that this variable does not account for unsuccessful tree planting since it counts only surviving trees.

Woodlot: a dummy variable for planting a personal woodlot = 1 if the individual planted a woodlot, 0 otherwise.

Community Wood: a dummy variable for planting a tree in the community grounds = 1 if the individual planted a tree in the common area, 0 otherwise.

Used: a dummy variable for using a tree in the community woodlot = 1 if the individual used a tree he or she planted in the community lot, 0 otherwise.

Treecount: a discrete variable for the number of trees planted in the homestead

Independent variables

Gender : a dummy variable for gender = 1 if woman, 0 man.

Poorest: a dummy variable for wealth level = 1 if the individual had a wealth level index of 0 or 1, 0 otherwise. To avoid linear dependence, this variable is not used in the regressions.

Moderate Income: a dummy variable for wealth level = 1 if the individual had a wealth level index of 2 or 3, 0 otherwise.

High Income: a dummy variable for wealth level = 1 if the individual had a wealth level index of 4 or 5, 0 otherwise.
Village 2: a dummy variable for living in the second group of villages surveyed = 1 if the individual lived in this village, 0 otherwise.
Gender/Moderate Income Interaction: a dummy variable for interaction effects of wealth and gender = 1 if the individual had a wealth level index of 2 or 3 and was a woman, 0 otherwise.
Gender/High Income Interaction: a dummy variable for interaction effects of wealth and gender = 1 if the individual had a wealth level index of 4 or 5 and was a woman, 0 otherwise.

Wealth ranking scale

Poorest

0 *Poorest:* Old people without family to take care of them, physically or mentally incapacitated people: live in poorly built houses of poles and mud, may have holes in the wall; struggle to get food, even *sadza* (stiff maize porridge), no cattle, no chickens, poor clothing, no fences around their fields (so, even if they farm, they may lose their crops to animals), children do not go to secondary school.
1 These are the same as category 0 except these are able bodied people who can work, and do work, as laborers for classes 4 and 5.

Moderate Income

2 *Poor:* Some have cattle, they can get *sadza* but have problems getting relish (meat and vegetables), might have shoes, might have gotten a radio in payment for work but can't afford batteries, modest housing, work as laborers for classes 4 and 5, their children go to secondary school intermittently at local day schools but have to drop out when money is scarce.
3 *Moderate income:* 1 or 2 cattle, may have chickens or goats, children and wives may work as laborers, may have a house in Harare, children go to rural day secondary schools or day schools in Harare.

High Income

4 *Richer:* own cattle; well-built house with tin roof, glass windows, brick; might have a car; children go to boarding school; own a house in Harare; own radio and/or t.v.
5 *Richest:* own cattle, own house/s in Harare, children go to boarding school, well-built houses (as above) might include solar panels, own business or rental property.

Appendix B: Truncated negative binomial models

Count data models are based on the Poisson probability distribution which is appropriate when the dependent variable is always a nonnegative integer, since the Poisson returns nonnegative predictions. With this type of data, count data models provide a better fit than the tobit or log normal models, which assume that the dependent variable is continuous.

Our data appear to be an appropriate dataset with which to apply count data regression methods. First, the observations are counts, in this case, counts of trees. Second, the data approximates a Poisson distribution, in which the number of occurrences of the event being studied is skewed towards the left and tapers off as the number of occurrences increases. Most people in the villages studied planted between 0–10 trees, since tree planting often supplements income rather than provides a primary source of income. Activities such as selling fruit are possible from even 1–2 trees. Therefore, we estimate the expected value of planting a tree, as expressed by the expected number of trees planted for each individual in the sample, by using a count data model.

One drawback of the Poisson distribution is the assumption that the mean of the dependent variable equals its variance. Few datasets, including our sample, fit this description. The average number of trees planted for the entire sample, including those who did not plant, is 5.97, and the variance is 269.35. The mean for those who planted is 11.10 while the variance is 446.43. Clearly, the Poisson would not be appropriate. Applying the Poisson model where this assumption does not hold leads to a downward bias of the estimates of the standard errors so that the t -statistics are higher than the true model. In addition, the low value of the mean number of trees planted discourages application of models based on the normal distribution.

Fortunately, other options are available. The negative binomial distribution loosens this restriction of the Poisson distribution and allows the mean to differ from the variance. The negative binomial model replaces the Poisson density function with the gamma, and it includes an extra parameter which we denote as α to the formulation to account for the variance in the sample data. The derivation of the negative binomial model assumes that the underlying random process is a Poisson process.

Truncated data refers to data in which all the observations above or below a certain point are dropped from the dataset, either because the researchers cut them out or the observations were not observed. With sample truncation, the parameter estimates of the negative binomial would be biased and inconsistent. The truncated negative binomial formulation corrects for the sample truncation and returns consistent and unbiased estimators when the model correctly specifies the population mean and the underlying data generating process(the factors leading to a choice of planting trees in the present case) is truly a truncated negative binomial process (Creel and Loomis 1990). To avoid sample selection bias, the formulation of the truncated negative binomial model estimates the probability of observing the given count conditional on the probability that the count observed is greater than the point of truncation, in our case, 0. While we test the model and report results on a full sample of observations, we truncate the dataset at zero. The truncated model estimates the probability that a certain count of trees is observed for an individual, given that the individual has planted at least one tree. The mathematical formulation and a more complete explanation of the Poisson, negative binomial, and truncated negative binomial are available from the authors on request.

A question arises as to whether age would make a difference in any of our models since an older person has had more opportunities to plant a tree, and the Poisson does not automatically correct for this effect. To address this issue, we ran all negative binomial models with dummy variables for age groups. Age was insignificant in all regressions. This allows more confidence in the regression procedures using the Poisson distributions.