Does Participatory Forest Management Encourage Tree Planting? An Example from Tanzania

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Abstract

The effectiveness of efforts to protect forests in lower-income countries from excessive degradation, such as through the introduction of participatory forest management, depends in part on how nearby rural populations respond to these efforts. In this paper we focus on tree planting on private land – an important yet understudied response. Combining a conceptual spatial landscape model with primary data, we demonstrate that villagers do plant trees in response to increased forest protection, but only when there are no unprotected forests within their landscape to which they can displace their extraction activities. Our research highlights how tricky it is methodologically to isolate this response in Tanzania, because both tree planting and the siting of forests under increased protection following the introduction of participatory forest management are responses to forest degradation.

Keywords: participatory forest management; tree planting; Tanzania; displace; spatial spillovers; leakage.

JEL Classification: Q2, Q23

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1. Introduction

Efforts are increasingly being taken by policy makers to protect both forests and forest-dependent livelihoods in lower-income countries. This often includes in the short term, and often in the longer term, preventing or curtailing nearby villagers from extracting from particular forested areas, sometimes combined with the offer of alternative livelihood opportunities or REDD payments to compensate for losses (Illukpitiya and Gopalakrishnan, 2015; Luswaga and Nuppenau, 2020). When forest-dependent households face such reduced access to forest resources due to such changes in forest governance, or indeed due to degradation, they can respond in a number of ways. Typical responses include a combination of collecting fewer non- timber forest products (NTFPs); switching collecting to a different less-protected forest; relying more on the market for a similar or substitute product; continuing to collect resources, albeit illegally, from the protected forest; and planting trees on their own land (Scherr, 1995; Gautam et al., 2000; Cooke, 2004; Robinson et al., 2005; Kulindwa et al., 2018). In this paper we focus on tree planting on households' own land within a landscape approach, important yet under-researched responses.

Our paper is motivated particularly by the recent changes in forest laws in Tanzania, specifically the 1998 National Forest Policy and the Forest Act of 2002 (MNRT, 1998, 2002a, 2002b). In common with many other lower-income countries where rural people are often highly reliant on forests as a source of NTFPs, income, and employment, degradation of Tanzania's forests is a common problem. Participatory forest management (PFM) in the form of either joint forest management (JFM) or community-based forest management (CBFM) has been introduced in Tanzania as an approach to protecting the country's forests (MNRT, 1998, 2002a, 2002b; Kajembe et al., 2005; Njana et al., 2013). In the early stages of PFM being implemented, whether CBFM or JFM, a natural consequence has been that villagers have worse access to forest resources because temporary or permanent moratoria on collecting forest resources are put in place to allow the forests to regenerate (Robinson and Lokina, 2011; Luswaga and Nuppenau, 2020).[1] A hope, if not an expectation, among policy makers and forest managers is that villagers will respond in a number of ways, including planting trees on their own land to replace resources such as fuelwood and timber to which they have lost access from the PFM forests in the short run and even in the long run (Robinson et al., 2011). Yet whether or not villagers have indeed planted trees to substitute for lost access to the forests has not been well studied in Tanzania.

[1] We recognise that there are clear differences between JFM and CBFM in Tanzania. JFM is introduced into government forests, and most often, certainly where we undertook our fieldwork, into what are classified as government preservation reserve forests where all collection of forest products is banned. In contrast, CBFM has been introduced into village forests and villages are given the authority to manage the forests including to determine what products can be collected from the forest and the rules governing this collection. However, we found that in the villages that we visited the PFM initiatives are relatively recent, and access restrictions have been imposed (sometimes temporary, sometimes permanent), whether the forests are under JFM or CBFM, on forests that were previously *de facto* open access. Our paper is therefore concerned particularly with the impact of access restrictions, rather than the type of PFM per se.

The early literature on forest resources typically addressed either forest management and non-timber forest product (NTFP) extraction (key examples include de Beer and McDermott, 1989; Fearnside, 1989; Poulsen, 1990; Jodha, 1986; Ganesan, 1993; Gunatilake et al., 1993; Reddy and Chakravarty, 1999; Bahuguna, 2000; Cavendish, 2000; Adhikari, 2005; Mahapatra et al., 2005 and Senganimalunje, 2016) or tree planting (including Heltberg et al., 2000; Cooke, 2000), but not both, thus missing potential complementarities or synergies between the two (Gausset et al., 2007).[2] Kohlin and Parks (2001) explore the opposite – the extent to which woodlots take pressure off natural forests. Our paper joins a small but growing literature that addresses whether changes in forest governance promote greater tree planting on villagers' own land. Cooke (2004) finds such a link between community forests and private tree planting in Nepal; and Skutsch's (1983) study of 18 villages in Tanzania finds that a shortage of firewood on common lands is an incentive for villagers to plant woodlots.

More recently the literature has started to address explicitly the link between tree planting on private land and participatory approaches to forest management. Mekonnen and Bluffstone, 2008; Kulindwa et al., 2018) find that where there is stricter management of common property forest management (CPFM) forests, households are more likely to grow trees on their own land. Bluffstone et al., 2008; Senganimalunje et al 2016) find more effective community-based forest management (CBFM) to be positively correlated with more trees of higher quality grown on nearby households' own land. Gausset et al. (2007) highlights land tenure and tree seedling costs as key constraints to tree planting on households' own land in Tanzania. Nepal et al. (2005) demonstrate that social network groups directly related to conservation activities, including community forest user groups, can have positive effects on private tree planting, taking the pressure of the communal forests. There is empirical evidence that the further a household is from common forest land, the greater the density of trees on their own land (Gilmour, 1995; Amacher et al. 1993; Cooke, 2000).

Although this observation may appear intuitive – that households are more likely to plant trees on their own land when their access to nearby common forests is reduced – the empirical analysis to date typically focuses on a particular forest and the governance of that forest. These analyses therefore ignore the possible response of villagers switching to alternate forests, rather than planting trees. In contrast, in this paper we take explicit account of how the landscape of forests around a village and the differential governance of these different forests allows for the possibility that villagers, rather than planting trees, switch their collection of forest resources to other forests that are less protected but more distant and that might not have appeared to be in the village's extraction "landscape" before the forest access changes.

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2 For a comprehensive survey of the literature that addresses the different motivations behind tree planting, see Cooke (2004).

We build on the analytical framework developed in Robinson and Lokina (2011) that models spillover effects – leakage – when villagers displace their resource extraction into alternate forests, if those forests are sufficiently close. We hypothesise that the landscape of forests around a village will influence whether villagers plant trees in response to changes in forest access, a possibility that has not been addressed in the empirical literature to date. Our paper provides empirical evidence of a natural hierarchy of responses to reduced access to forests, in which villagers compare the costs of displacing their collection activities into a more distant but either less degraded or less protected forest, or planting trees on their own land. Only when the cost of displacement activities is sufficiently high (in this paper's example, proxied by when there is no nearby unprotected forest) will households be more likely to plant their own trees.[3]

Our paper is structured in the following way. In the following Section 2 we provide detail of our data collection and the econometric specification that we use to test our hypothesis, which takes into account that PFM is typically introduced into forests that are already degraded, such that both tree planting and the introduction of PFM can be responses to degradation. Tree planting may therefore signal degradation in addition to changes in forest governance that follow. In Section 3 we present our findings and we conclude our paper in Section 4 by discussing discuss the policy implications of our research for PFM in the light of our findings.

2. Methodology

Our analytical framework is informed by two important observations. First, villagers may displace their collection of NTFPs from the newly designated PFM forest into less-protected forests, where these are part of the extended village landscape (Robinson and Lokina, 2011; Robinson et al., 2011; Lokina, 2012) and so not have a need to plant trees. Much of the literature implicitly ignores this "leakage" (kulindwa et al., 2018; Luswaga and Nuppenau, 2020). Second, in Tanzania, the introduction of PFM is itself often a response to degradation – typically PFM is deliberately introduced into areas where the forests have been degraded through over use and lack of management. It is not clear therefore whether observed high levels of on-farm trees are a response to PFM, a response to earlier forest degradation, or both, suggesting that the timing of tree planting relative to the introduction of PFM is important.

The data for our paper come from a larger data set developed as part of the Environment for Development-funded project "The Determinants of Participatory Forest Management in Tanzania". We collected data from just over 1000 households in Tanga and Morogoro regions of Tanzania. We purposively selected these two regions because PFM has been introduced in the past ten years. We administered a survey to a random sample of 20-25 households per village in 50 randomly selected villages. The key individual household questions that link to this paper concern whether the households

[3] Naturally, there are other responses that are not the focus of this paper, such as undertaking more wage labor or purchasing from a nearby market, though neither of these may be options for many of the households that we interviewed.

had planted trees on their own land, how many, how long ago, which species, and for what purpose. As is the case for most if not all of the villages and forests in Tanzania, baseline data were not collected prior to the introduction of PFM with respect to forest quality nor tree planting. We therefore rely on recall data, whilst recognising that there are a number of problems associated with taking such an approach.

We combined these data with a separate survey, undertaken at the village level in the same 50 villages, using a structured focus group approach. Each focus group comprised of village officials and members of the Village Environmental Committees (responsible for forest management in JFM and CBFM forests) and other men and women from the village. These villagers drew maps showing the landscape of forests around their villages the management regime for each. We determined how many PFM initiatives were in place and if so in which forests; the type of PFM, specifically whether JFM or CBFM; when the initiatives were started; and the nature of the access restrictions imposed by the PFM. Combining the household and village level datasets provided us with a rich data set concerning households' choices of trees and decisions over whether to plant trees.

2.1 Econometric specification

Testing whether villagers do indeed plant more trees in response to the changes in forest management brought about by PFM poses a number of specific empirical challenges for our econometric analysis, particularly with respect to endogeneity. First, although the choice of where PFM is introduced is naturally informed by many factors, in Tanzania PFM has typically been introduced in areas where the forests have been degraded and so are perceived to be in particular need of protection against unregulated collection of forest resources. Second, any observed correlation between the introduction of PFM and private tree planting could be due to reverse causality or due to omitted variables that affect both. We need to separate tree planting in response to reduced access to resources due to degradation, and tree planting in response to reduced access due to PFM which in turn may be due to degradation. Third is the fundamental challenge in separating the effects of introducing PMF, the presence of alternative forests, and degradation on villagers' tree planting, due to potential collinearity between these explanatory variables.

To address these empirical challenges we use a multivariate maximum likelihood approach, fitting our data to a Probit function to estimate the probability of planting trees as a function of different types of PFM, controlling for the presence of alternative forests and access to farmland. We hypothesise that initiatives such as participatory forest management (PFM) are typically introduced into forests that are already degraded and where villagers have already responded to this degradation by planting trees (Equation1). Our specification links the probability of planting trees (we explore both trees planted in the past five years and in the past ten years) to different types of PFM (JFM and CBFM) with and without alternative forests from which villagers can collect forest resources, controlling for the area of agricultural land per individual a household has access to (Equation 2). Equation 1 and Equation 2 are estimated jointly[4].

$$\text{PFM}_i = \alpha_1 + \beta_{11}\text{past tree planting}_i + \beta_{12}\text{farmland per person}_i + \delta_i + \varepsilon_i \qquad (1)$$

with δ_i representing a district dummy.

We test whether the presence of PFM, with or without an alternative unprotected forest from which villagers can collect forest resources, was influenced by past degradation to which villagers have already responded by planting trees. We regress the presence of PFM with or without an alternative unprotected forest over a past tree planting measure, defined as the proportion of trees in a particular village planted more than ten years ago. We then consider whether villagers plant yet more trees as a consequence of PFM being introduced, when controlling for the presence of alternative more distant non-PFM forests that can substitute for tree planting. We consider both trees planted in the past five years and trees planted in the past ten years as the dependent variable.

$$\text{trees planted in past 5/10 years}_i = \alpha_1 + \beta_{21}\text{JFM}_{it} + \beta_{22}\text{CBFM}_i + \beta_{23}\text{JFMPLUS}_i + \beta_{24}\text{CBFM}_i + \beta_{25}\text{farmland per person}_i + \delta_i + \varepsilon_i \qquad (2)$$

where δ_i represents the district dummies.

4. Findings

In this section we first present some summary statistics on tree planting behaviour from our sample of villagers. We then present the output from our econometric analysis.

4.1 Data analysis

Overall 77 percent of households, or their ancestors, have planted trees on their land. Most of these households have planted up to thirty trees, with a small number having planted over 100 (Figure 1).[5] Households have planted a wide variety of trees. Table 1 itemises the different tree varieties. Where possible we have included both the common and scientific names, and the most common uses to which these trees are put, according to discussions with local foresters. The top three reasons households gave for planting particular types of trees were fuelwood, building materials, and fruits (Table 2 & Figure 2). It is perhaps not surprising that fuelwood is given as the most important reason for a household to plant trees on its own land given that in the rural areas where we undertook our survey most households rely exclusively on fuelwood to meet their cooking needs and it is rarely purchased. Although medicinal plants are an important NTFP collected by households (Robinson and Kajembe, 2009), our survey suggests that for this particular resource, trees planted on households' own land do not appear to be a substitute for common land forests.

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[4] We included other household characteristics such as gender, age, and household size but none of these were significant.

[5] We asked respondents the following question: "If you have planted trees on your land, how many have been planted by you or your ancestors?"

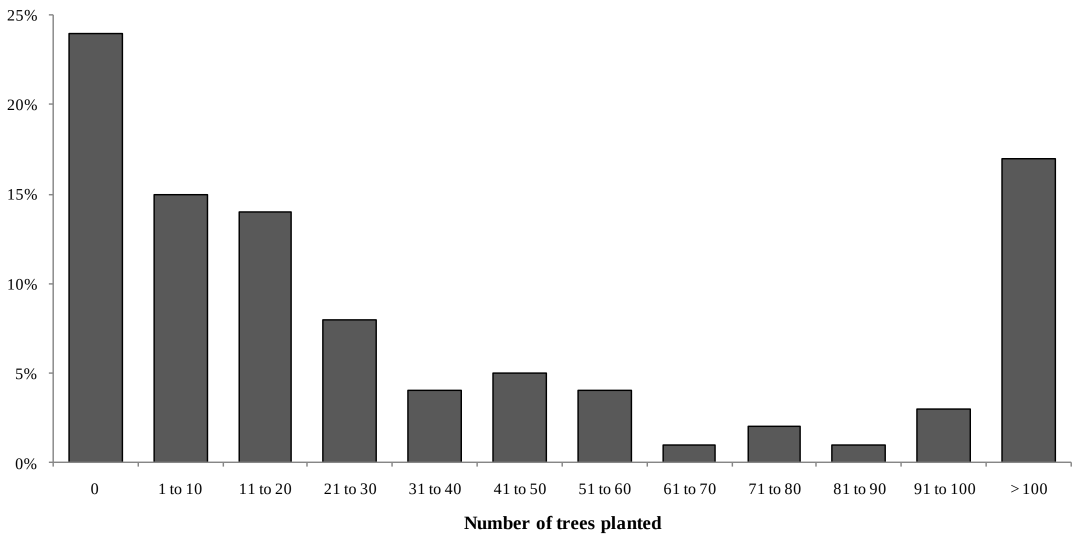

Fig. 1. Number of Trees Planted by Each Household

Table 1: Most common trees species planted on households' own land

Type of tree species*			No. of households mentioning		Uses/benefits from trees, recognised by foresters
Local name	Common name**	Scientific name**	Freq.	Percent	
Migiriveria		*Grevillea robusta*	127	12.4	Timber, firewood
Minazi	Coconut	*Cocos nusifera*	105	10.3	Fruits, timber
Misedere		*Cedrella odorata*	66	6.5	Timber
Miembe		*Mengifera indica*	45	4.4	Fruits, timber
Mitiki	Teak	*Tectona grandis*	42	4.1	Timber
Mikabela			32	3.1	
Midalasini	Cardamom		31	3	Spices
Michongoma		*Dovialis cafra*	29	2.8	Fence, amenity
Mikaratusi		*Eucalyptus sp.* ***	28	2.7	Firewood, timber
Mijohoro		*Senna siamea*	21	2.1	Amenity, shed, firewood, medicinal
Mikorosho	Cashew		18	1.8	Cashew nuts
Mikangazi		*Khaya sp.*	16	1.6	Timber
Mikarafuu			12	1.2	Spice
Wattle/Acasia		*Acacia siamea*	11	1.1	Firewood/wood fuel
Agrocopus/Mikopas		*Acrocarpus sp.*	9	0.9	Soil fertility, firewood
Mipine/pines	Pines	*Pinus sp.*	9	0.9	
Misaji			8	0.8	Amenity
Cocoa			8	0.8	Fruits
Mikabela			7	0.7	
Mibokoboko			7	0.7	
Mifenesi	Jack tree	*Artocarpus altilis*	7	0.7	Fruits, timber
Mipeas	Pear		6	0.6	Fruits
Miparachichi		*Persia american*	6	0.6	Fruits, timber
Miarobaini	Neem	*Azadirachta indica*	4	0.4	Medicinal, shed, amenity
Micyprus	Cypress	*Cupressus lucitanica*	4	0.4	Timber, Christmas tree
Lulina		*Leucaena leucocefala*	4	0.4	Fodder, soil erosion control
Mikarafuu			3	0.3	Spices
Mishai		*Albizia versicola*	3	0.3	Timber, soil fertility
Cassia trees		*Cassia sp.*	3	0.3	Amenity
Mikamba			2	0.2	
Mifleta			2	0.2	
Mivumo		*Ficus sp.*	2	0.2	
Minyaweza		*Grevillea robusta*	2	0.2	Timber
Mibono		*Jatropha curcas*	2	0.2	Soap, candle, bio- diesel

*A number of species were mentioned just once: *Miti Ulaya; Micafye; Milonge; Mikomba; Mikame; Mtindi; Mifumbili; Misufi; Mikuyu; and Mikungu.*

** Not all species mentioned by villagers had an identifiable scientific or common name.

*** sp = species, used where there is more than one species name within the same genus.

Further, Figure 2 shows the expected benefits from tree planting. Majority of the household are planting tree for fuelwood and fruits. This should be expected since the rural areas fuelwood account for more than 90% of energy requirements. Fruits are important as a source of income at the household level but also the home consumption.

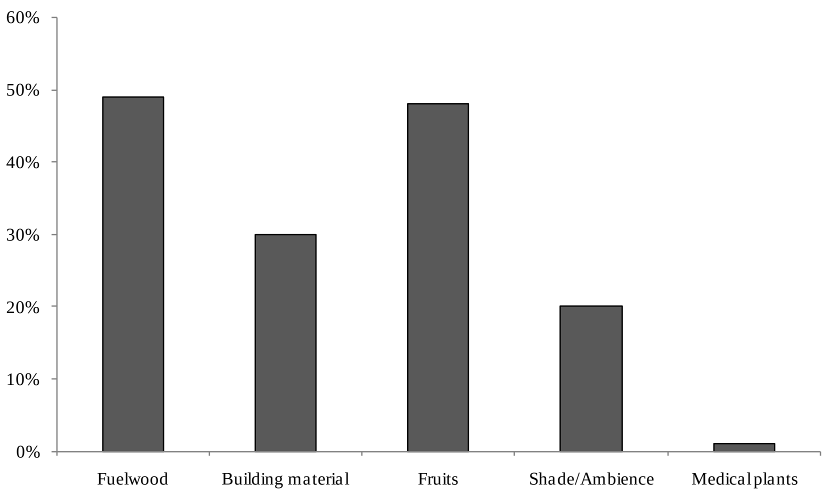

Figure 2: Benefits from planting trees

Villagers are more likely to have planted trees on their own land in villages that are involved in a PFM initiative (Table 2), consistent with the literature (for example, Mekonnen and Bluffstone, 2008; Bluffstone et al., 2008).[6] Indeed, fewer than half of households in villages without a PFM initiative have planted trees on their land, whereas over 80 percent of households involved in some type of PFM have. Yet Table 2 also reveals that households near PFM forests, whether JFM preservation forests and CBFM forests, are more likely to have been planting trees on their own land for many years before any PFM initiative was introduced, whereas households where there is no PFM (either JFM or CBFM) are much less likely to have planted trees whether recently or more than ten years ago.

[6] Villagers in these regions are rarely involved in tree planting on village or government land and so we focus on trees planted on own land.

Table 2: Incidence and timing of tree planting on households' own land

Type of PFM in village	Percentage of households that planted most trees on their own land:				Did not plant trees	Number of households
	Up to 5 years ago	Up to 10 years ago	More than 10 years ago	Not specified*		
None	12%	7%	9%	16%	56%	76
JFM (preservation)	26%	20%	34%	3%	17%	401
JFM (production)	18%	11%	14%	16%	41%	28
CBFM	20%	26%	32%	0%	22%	198
JFM and CBFM	15%	17%	26%	21%	21%	116

* A number of households did not specify one of the particular time periods because they had planted trees over a long period of time.

These data support the finding from our village-level focus group discussions with villagers, village representatives, and NGOs and foresters working in the region: that locations for PFM and CBFM have been chosen where degradation has already been significant and therefore forests are in particular need of improved management. In these areas households may already have naturally switched from relying wholly on the forests around them to also using their own land to plant trees and collect forest products, before any initiative to protect and regenerate the forests. This is particularly true of CBFM in village forests, which have historically been less protected than the government preservation and production forests where JFM is being introduced.

Therefore, the data support the hypothesis that tree planting and the introduction of PFM are both in response to degradation of the nearby forests. The introduction of PFM appears to have encouraged further tree planting, suggesting access to forests is reduced yet further as forest managers attempt to facilitate the regeneration of the forests by imposing moratoria on the collection of forest products.

To explore the possibility of leakage – spillovers/displacement into more distant forests – we look in more detail at the landscape of forests around a village. Our summary data appear to support theoretical work in this area (Robinson and Lokina, 2011; Robinson et al., 2011), which suggests that households are more likely to have planted trees in response to PFM where there are no alternate nearby forests from which the villagers could switch their collection of forest resources (Table 3). For example, in villages where PFM has been introduced and where there are no alternative forests 45% of households have planted trees in the past ten years, compared with 13% where there are alternative forests (Table 3). This suggests that villagers do indeed "displace" their collection of tree products into less protected forests when PFM is introduced, if they can, rather than planting trees on their own land.

Table 3: Influence of less- protected forests on private tree planting

Whether or not villagers have access to non- PFM forests	Whether households have planted trees on their own land			
	Yes, mostly in past 5 years	Yes, mostly between 6 and 10 years ago	More than 10 years ago or not specified	None planted
No PFM	12%	7%	25%	56%
PFM and no alternative forest	23%	22%	36%	19%
PFM and alternate unprotected forest	12%	11%	55%	22%

4.2 Econometric assessment of drivers of tree planting

To explore more rigorously this possibility of displacement into other forests rather than replacement through planting trees, we present the results from our econometric assessment. Our regression analysis confirms that reduced access to forests due to PFM does indeed increase the probability of individual households planting trees. Whether the probability of tree planting in the past five or past ten years is considered, the probability of having a PFM forest in a particular community is positively correlated to past degradation (for which the proportion of trees planted in a particular village more than ten years ago is used as proxy), even after controlling for other factors that might explain the presence of PFM (Table 4).

Table 4. Tree Planting Regressions

	Trees planted in last five years	Trees planted in last five years	PFM	Trees planted in last ten years	Trees planted in the last five years
cost of fuelwood from tree if purchase	−0.000022* (0.0000132)	−0.0000183 (0.0000151)			
School attainment	−0.0046 (0.040)	0.0027 (0.045)			
male	0.057* (0.024)	0.069* (0.028)			
Time spent finding forest resources compared to ten years ago	0.051*** (0.015)				
Quantity of the resources collected now compare to ten years ago		−0.037** (0.0153)			
Past tree planting			0.670*** (0.094)		
Condition of wood lot forest during the time PMF was initiated			−0.168*** (0.027)		
Agricultural population density			0.0018 (0.0059)		
JFM without alternative forests				0.080** (0.046)	0.070** (0.036)
CBFM without alternative forests				0.139** (0.065)	0.053 (0.051)
JFM with alternative forests				−0.018 (0.055)	0.0041 (0.044)

The probability of households planting trees in the last 5 years significantly increases with both JFM and CBFM only when there is no alternative non-PFM forest (Table 5). For example, where JFM programs are present but no alternative non-PFM forests from which villagers can collect non-timber forest resources, the probability that a household has planted trees in the past five years is 0.46 greater. Where there is CBFM with no alternative non-PFM forest, the probability that a household has planted trees in the past five years is 0.12 greater. When there is an alternative non-PFM forest, tree planting as a response to both JFM and CBFM is not significant. When we consider households planting trees over the past ten years, the results are similar, though the probability of tree planting in response to CBFM remains significant even with the presence of alternative non-PFM forests. Access to farmland (measured by units of land per person) in both cases (10 years and 5 years) decreases the probability of planting trees (Table 5).

Table 5: Tree Planting Regressions

	Trees planted in last five years	Trees planted in last five years	PFM	Trees planted in last ten years	Trees planted in the last five years
CBFMwith alternative forests				0.196***	0.092
				(0.079)	(0.070)
land ownership per person				− 0.053***	− .029**
				(0.019)	(0.014)
mvomero				− 0.247***	− .070**
				(0.036)	(0.031)
korogwe				− 0.282***	− 0.133
				(0.032)	(0.026)
muheza				0.111**	0.111***
				(0.053)	(0.044)
lushoto				− 0.224***	− 0.098***
				(0.036)	(0.02)
cons	− 2.826***	− 0.748	3.206***	− 0.612	− 0.835***
	(.991)	(1.138)	(0.587)	(0.142)	(0.1580)
Number of observation	199	199	470	991	991

[a] ***, ** and * for the 1, 5, and 10 per cent level, respectively, with standard errors in parentheses.

5. Policy Implications

Overall, we find that many households do plant trees on their own land, particularly as a source of fuelwood and building materials, resources that might otherwise be extracted from natural forests. Importantly, this suggests that trees planted on households' own land are reducing pressure on the nearby forests. Moreover, these are resources collected by both women and men: in particular it is women who tend to collect fuelwood, and men who typically collect building materials (Robinson and

Kajembe, 2009). Our findings thus agree with the empirical literature, in as much as we find tree planting to be a natural response to worsening access to forests, whether due to degradation or changes in access restrictions. However, because we have taken a landscape approach that accommodates both degradation before the introduction of forest access restrictions and the possibility of households collecting from multiple forests, the findings from our paper allow us to contribute a number of new insights to forest policy discussions.

First, our data show that the introduction of access restrictions alone, such as due to PFM, is not sufficient to drive private tree planting and so reduce pressure on natural forests. Importantly, villagers appear to plant trees only if the option to switch their extraction to more distant but less protected forest is not available. This finding suggests that policy makers need to take a landscape approach to implementing PFM initiatives, as predicted in the theoretical paper (Robinson and Lokina 2011). Second, if a higher density of trees on private land is observed where PFM has been introduced, this may reflect a response to earlier degradation, rather than a response to the PFM initiative, which itself is likely also to be a response to degradation. Third, villagers appear to choose to spend additional time going to more distant but less protected or less degraded forests rather than planting trees on their own land, so long as these forests are within some viable extraction "landscape". This is perhaps not surprising, particularly for fuelwood, which is collected mainly by women who may have less access to the cash needed to purchase tree saplings.

Finally, our paper demonstrates the importance of taking a spatial-temporal perspective on forest management. Forest landscapes are rarely in equilibrium. Rather, gradual forest degradation over time is likely to change both policy makers' decisions over where to focus forest protection efforts, and villagers' decisions over from which forests to extract, and these decisions may interact in ways that are hard to predict.

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