Households and tree-planting for wood energy production – Do perceptions matter?

Citation for the original published paper (version of record):
Kulindwa, Y., Ahlgren, E. (2021)
Households and tree-planting for wood energy production – Do perceptions matter?
Forest Policy and Economics, 130
http://dx.doi.org/10.1016/j.forpol.2021.102528

Forest Policy and Economics 130 (2021) 102528

Contents lists available at ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

Households and tree-planting for wood energy production – Do perceptions matter?

Yusuph J. Kulindwa [a], Erik O. Ahlgren [b,*]

[a] Department of Economics and Statistics, Moshi Cooperative University, Tanzania
[b] Division of Energy Technology, Department of Space, Earth and the Environment, Chalmers University of Technology, SE-412 96 Gothenburg, Sweden

ARTICLE INFO

Keywords:
Tree-planting
Wood energy
Perceptions
Tanzania

ABSTRACT

While forests are a primary source of energy for the majority of Tanzanian households, the forest cover is rapidly declining. The Tanzanian government has introduced a tree-planting campaign strategy, aimed at reducing pressure on natural forests. However, the campaign appears not to have contributed significantly to the forest recovery rate. Thus, this study aims at examining household perceptions of tree-planting for wood energy production for both in-house uses and for sale, and identify the factors influencing household perceptions of tree-planting. We employed the multinomial logit model to analyse the factors influencing household perceptions of tree-planting for energy. Our findings indicate that respondents considered the right/freedom to harvest trees from farms and transport them to markets as the most important factor (86%), followed by lack of awareness of tree-planting programmes (72%), and the existence of fuelwood for free from natural forests (59%). The size of the farm, education, distance to forest reserves, and age of the household head are found to have significant impact on the household perceptions of tree-planting for energy. Our results further show that woodfuel harvesting and enforcement systems do not exist in nearby forests. This situation is exacerbated by the absence of a specific policy formulated to match with the daily demand of forest produce for energy and income of households near forest reserves. Thus, we suggest policy makers to target policies and actions promoting tree-planting for energy.

1. Introduction

Globally, about 2.5 billion people depend primarily for their energy needs on fuelwood (IEA, 2006; USAID, 2009). Fuelwood is the most commonly used fuel source for cooking and heating in developing countries, and forest biomass is thus the main source of energy (Mwampamba et al., 2013). About 13% of the world's primary energy is obtained from natural forests (Haile et al., 2009). East Africa is a region where the dependence on forest biomass for households' basic energy needs is very strong. In Kenya and Uganda around 80% and 90%, respectively, of households depend on fuelwood, mainly from naturally growing trees (GoU, 2010), and in Tanzania this figure is as high as 94% (URT, 2014).

The main reasons for deforestation are the excessive use of wood for energy from natural forests, which includes households′ fuelwood consumption (Chidumayo and Gumbo, 2013), and agricultural land expansion (Khan and Khan, 2009; Mwampamba et al., 2013; Assefa and Bork, 2014). Many studies have reported that most countries in Sub-Saharan Africa annually lose about 0.5% of their total forest cover and gain little from tree-planting activities and forest regeneration (e.g. Miah et al., 2011; Mitchard and Flintrop, 2013; Chidumayo and Gumbo, 2013). In Tanzania, the total forest cover decreased at net annual rate of 1.16% (403,000 ha) with an annual recovery rate of only 0.32% (109,000 ha) between 1991 and 2010 (Kulindwa, 2016; World Bank, 2013). Over 70% of the woodland extraction that resulted in deforestation was harvested to meet households' fuelwood needs (Msuya et al., 2011; Chidumayo and Gumbo, 2013).

Traditionally, households in Tanzania exploit natural forests for fuelwood without replanting trees. Several development projects have been established to enhance forest restoration through tree-planting

* Corresponding author.
E-mail address: erik.ahlgren@chalmers.se (E.O. Ahlgren).

https://doi.org/10.1016/j.forpol.2021.102528
Received 25 November 2019; Received in revised form 3 April 2021; Accepted 11 May 2021
Available online 22 June 2021
1389-9341/

programmes (Malimbwi and Zahabu, 2008).[1] However, the success of these programmes depends on households' tree-planting behaviour, which is influenced by their perceptions of tree-planting and other determinant factors, such as expected income, the socio-economic context and constraints that limits execution of programmes action (Coulibaly-Lingani et al., 2014). Consequently, even with the best goals and greatest potential benefits, tree-planting programmes fail when they are negatively perceived by the households (Zubair and Garforth, 2006; Tesfaye et al., 2011).

In this study, the term tree-planting refers to tree stands of exotic and/or native species that are planted and/or deliberately seeded on private land or village land holdings. Planted trees are projected to supply up to 80% by 2030 of global annual wood harvests as the source of energy (Ramage et al., 2017). Tree-planting practices constitute a significant source of fuel in developing countries and provides extensive benefits that improve households' livelihoods (Ruseva et al., 2015). Essentially, the main reasons for planting trees are the great demand for their products and the slow restoration rate of natural forests, resulting in deforestation (Brown et al., 2015).

Households in the areas of study usually fell trees in forests on communal land (defined as unoccupied or public land), for which clearly defined management regimes are lacking (URT, 2012). Depletion of large trunks for charcoal production means that increasingly the size of the trees selected for charcoal production is becoming irrelevant. Sometimes, even stumps are being used for energy purposes (Chidumayo and Gumbo, 2013). Tree-planting campaigns aim to increase households' incentives to grow trees for fuelwood, and household involvement is an effective means of implementing tree-planting programmes (Bidogeza et al., 2009). It is also suggested that, with households' involvement in tree-planting areas, planting objectives become easier to achieve (Martini et al., 2011). However, projects for tree-planting for energy in Tanzania have been unsuccessful (Kindo et al., 2010). Although most studies recognize the loss of forest cover as a problem that impacts households, little is understood regarding the connection between households' perceptions about tree-planting programmes, forests' economic attributes, and policies that are designed to promote change.

In the past and also recently, forest conservationists and economists have acknowledged the importance of household perceptions of forest management programmes (Buffstone et al., 2008; Primmer et al., 2014; Joa and Schram, 2020) but very limited attention has been explicitly given to include household perceptions in programmes for tree-planting for energy. The literature suggests that tree-planting programmes are a useful component of forest recovery interventions (Bennett, 2008; Yin and Yin, 2010). A household that is aware of and concerned about the forest and its benefits, and has favourable perceptions about the importance of the forest and also the skills and motivation to recover the forests, is likely to plant trees. (Coulibaly-Lingani et al., 2014; Fouladbash and Currie, 2014). Thus, a better understanding of household perceptions about tree-planting and awareness of the benefits of tree-planting could reinforce the involvement of households in tree-planting programmes.

In the rural areas of Tanzania, households obtain fuelwood through customary practices that continue to govern how land is acquired. Households acquire land by felling trees on public or reserved land and this practice is still recognized by the government (Blomley et al., 2008). However, it may negatively influence household perceptions of tree-planting for energy because if households start planting trees for energy, they would no longer need to fell trees on public or reserved lands and, consequently, will no longer acquire land.

In Tanzania, *de jure* rights to harvest, transport and trade in forest products are matters for the harvesting committees at district level. These committees' tasks include defining standards for granting permits to harvest and transport of planted tree or natural forest products, and approving applications for permits (URT, 2007). However, there is no defined difference in treatment between natural forest and planted tree products in terms of permits. Due to the high cost of obtaining permits, both in terms of distance to the district forest officers and waiting time for permits, around 80% of trade in forest products, such as charcoal, is undertaken informally, reflecting weak policy management (World Bank, 2009). This also applies to other developing countries (Roshetko et al., 2008; Perdana et al., 2012).

Due to the lack of policy incentive-related factors (such as subsidies for those who plant trees, a well-structured system of felling trees on one's own farmland and freedom of the households to sell tree products from their farms) to enhance compliance with licensing requirements, both village and district officers (law enforcement staff) are tempted to offer and accept bribes of those seeking permits to avoid transaction tariffs because, on average, bribes cost less than permits (World Bank, 2009; Robinson and Lokina, 2012). Despite the Forest Act of 2002, the high demand for forest products for energy use has led to much of the trade in tree products being conducted illegally. In 2006, the government even attempted to ban the trade in charcoal, despite the de facto demand, but this simply attracted more illegal trade in charcoal, bribes and roadside business, which persisted even after the trade was again legalized two weeks later. Thus, the lack of such policy incentive-related factors may influence household members' perceptions of tree-planting for energy negatively.

Although studies on factors influencing tree-planting behaviour in developing countries have enriched the literature on reforestation (Kallio et al., 2010; Mekonnen and Damte, 2011), none has examined household perceptions of tree-planting for energy and how the perceptions influence related decisions. Thus, the aim of this paper is to fill this knowledge gap. The key questions are: What are household perceptions of tree-planting for energy? What are the main factors influencing household perceptions of tree-planting for energy? Which policies would favourably influence perceptions towards tree-planting for energy?

The rest of this study is structured as follows: Section two focuses on the theoretical framework, including analytical framework, section three describes data collection and the empirical model of the study, sections four present results, section five discusses the results and, finally, section six draws conclusions.

2. Theoretical framework and studies overview

The concept of perceptions has been understood and defined in different ways. Clausen (1977) defined perception as a way of understanding or interpreting what an individual has seen and/or heard, based on information that has been received, whereby people may differ in behaviour, feelings or motives. Hung and Michael (2005) defined perception from different theoretical perspectives. According to Stoneham (2002), perceptions are ideas, and ideas are generated at the basis of awareness, and a perception both depends on the perceived object being an idea and is independent of it since it is real. We define perceptions as the way household members hear and observe an action, understand the action, interpret it, and evaluate its various objects, experiences, and outcomes.

Researchers have employed diverse theories to study the link between the perceptions of tree-planting and forest management strategies (Kallio et al., 2010; Hajjar and Kozak, 2015). The work of Primmer et al. (2014) on local perceptions of forest management shows that household perceptions of the attributes of a new initiative are important if they are to accept it and get involved. Blayac et al. (2014) found that perceptions

[1] The Tanzanian government with the support of Norwegian Agency for Development Cooperation (NORAD) has established tree-planting programmes to ensure that fast-growing trees that produce a lot of fuelwood are planted. To achieve this goal several tree-planting campaigns have been implemented to generate energy for home use and trade so as to reduce the pressure on natural forests. This includes the establishment of the Ruvu Fuelwood Project in 2000.

of ecosystem services were significantly affected by age and education.

Hajjar and Kozak (2015) employed cultural theory to elucidate household perceptions of tree-planting and found a positive correlation between perceptions and planting, while Vossler et al. (2012), using utility maximization theory to investigate household perceptions of tree-planting, found a significant correlation between household perceptions of tree-planting and demand for tree products by households. However, this link between household perceptions of tree-planting and demand for tree products is only associational; the market for fuelwood from tree-planting is expected to satisfy the demand, granting a good price in the market as a policy instrument that ensures that households gain from planting trees.

Some studies have focused on perceptions of individuals of tree-planting/forest management (Coulibaly-Lingani et al., 2014; Primmer et al., 2014). Others have built on forest policy and a perceived functioning market for forest products (Zubair and Garforth, 2006; Fouladbash and Currie, 2014), which we found to influence households' tree-planting behaviour. These studies show the perceived need for forest products by households, which implies that household perceptions have a major influence on promoting tree-planting and forest management.

Household perceptions of the economics of planting and using the natural forests are an essential link to the actual action that influences them whether or not to engage in planting trees, accept tree-planting programmes or be concerned about deforestation (Nguyen et al., 2010). Other studies appreciate the influence of policy instruments on household perceptions of forest management, such as subsidies and tax exemptions, clear rules on access to forests for extraction and fixed allotments of fuelwood (Fullerton and Mohr, 2003; Mekonnen and Bluffstone, 2008). We argue that a study aimed at understanding household perceptions of tree-planting/forest management must take into consideration the role of policy instruments with regard to household perceptions of the economics of planting trees and using natural forest resources.

Although studies on household perceptions have been carried out; there has been limited research on tree-planting programmes for producing fuelwood in developing countries as compared with research on forest conservation and forest reserves. This study, therefore, is important because there is little empirical evidence of household perceptions as drivers of tree-planting for energy.

3. Study methodology

3.1. Analytical framework of the study

In this study, we model policy instruments and economic factors as constraints to households planting trees for fuelwood (McCarthy et al., 2003; Mekonnen and Bluffstone, 2008). Our theoretical framework builds on the work of Fullerton and Mohr (2003) and Mekonnen and Bluffstone (2008). Specifically, we presume that households are only likely to engage in tree-planting when the utility from observed and unobserved factors is greater than the cost of planting trees, including the opportunity cost of time (days) allocated for tree-planting.

Taking into account the spatial patterns of forest extraction within different buffer zones closer to villages and households' interactions with it (Fig. 1), social planners need to induce the optimal level of extraction. We model the policy instruments[2] as an approach to achieving sustainable forest management. This model comprises extractors and regulators of forest products, whose actions are interdependent (see annex A).

3.2. Data collection and description

We designed a questionnaire to obtain the data used in our study. The data were collected from 11 villages in the Pwani and Morogoro regions of Tanzania during 2014–2015. Tree-planting programs have been or still are active in these regions, with trees planted on households' farms and near homestead places. In addition, these two regions are near Dar es Salaam, the country's largest city, where primary tree products are sold, commonly as traditional biomass (e.g. charcoal, logs and wood pellets).

Upon entering each village, there was a discussion with a key informant to identify households who plant trees and those who do not. In the process of gathering the data, two districts from each region and three villages from each district were purposefully selected because they had active tree-planting programmes.

A stratification design was employed. In the 11 selected villages, a list of households was drawn up and households categorised into two strata, those who had planted trees and those who had not.[3] Whether a household planted trees in the village or not was used as stratification criteria. From this list, 10 households from each stratum were randomly selected, giving a sample of 220. However, 18 of these households could not be interviewed or were discarded due to incomplete information resulting in a sample of 202 households, 109 of which were engaged in tree-planting.

The questionnaire was tested in the field before doing the final fieldwork to verify and modify it where necessary (Annex C: The main sections of our questionnaire). Using four trained enumerators, we administered our survey for data collection. The interviews were conducted using the Kiswahili language. Several data were collected such as gender, age, family size, and education level of the head of the household. Other variables included were household tree-planting, whether the household planted trees or not, the right to harvest and transport tree products to markets, the number of trees planted, the location of the forest, trees planted near homestead, and the reason for tree-planting.

Simple questions and answers of consent, yes, or no; perceptions, what, how, do you think, were asked to respondents. The questions mentioned in Fig. 2 to Fig. 6 were also included in this questionnaire. Further, the questionnaire was designed to capture household perceptions of tree-planting. Interviews were conducted with the heads of households. Before the interviews with the heads of households, we briefed about the purpose of our study to obtain their informed consent and willingness in participation (Annex D: Ethical approval and consent granted). Both households engaged in tree-planting activities and those not planting trees were interviewed. This enabled the enumerator to choose a set of specific questions for each specific stratum. For example, the question *"Do the people close to you have a positive perception of tree-planting for wood energy*?" would only be asked to those engaged in tree-planting and the respondents could choose between definitely positive (coded yes), probably yes, not sure, probably no, and definitely no.

The motivation and perception questions that were asked of those households not involved in planting trees included *"What are the three most important factors that influenced your family not to plant trees for fuelwood?"* We also included the issues most frequently mentioned during the discussion with the key informant in each village and framed questions accordingly. These questions included belief or perception items, from which a respondent had to choose from the possible answers provided by the researcher. For example, seven options concerned the perception of households regarding factors preventing them from planting trees for fuelwood. The respondents were asked to choose the three most important perceived factors that prevented them from doing

[2] We consider price, subsidies, tax and right policy instruments in this study which include the right to use the resource (in this case wood energy).

[3] Following information obtained from the village heads, households in each stratum comprised at least twenty names of household heads, listed in alphabetical order in a roster from one to twenty. Ten households from each stratum were randomly selected for interviews.

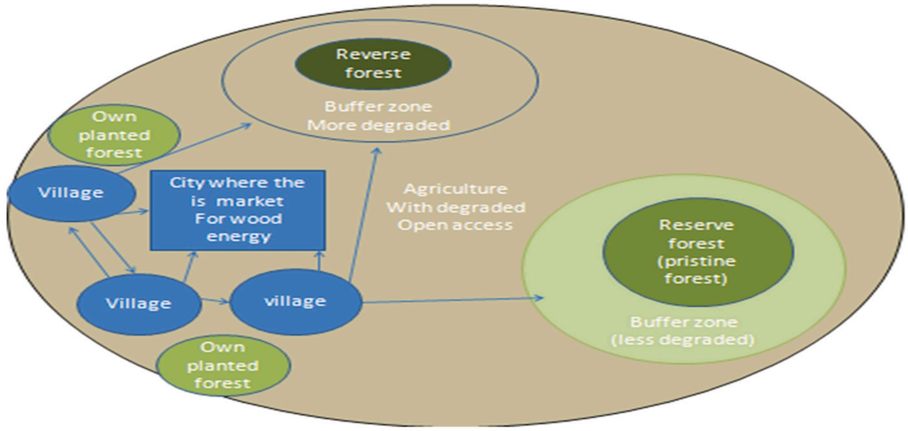

Fig. 1. The figure presents the spatial patterns of forest extraction within reserve forests that the policy instruments assume to take into account through tree-planting.

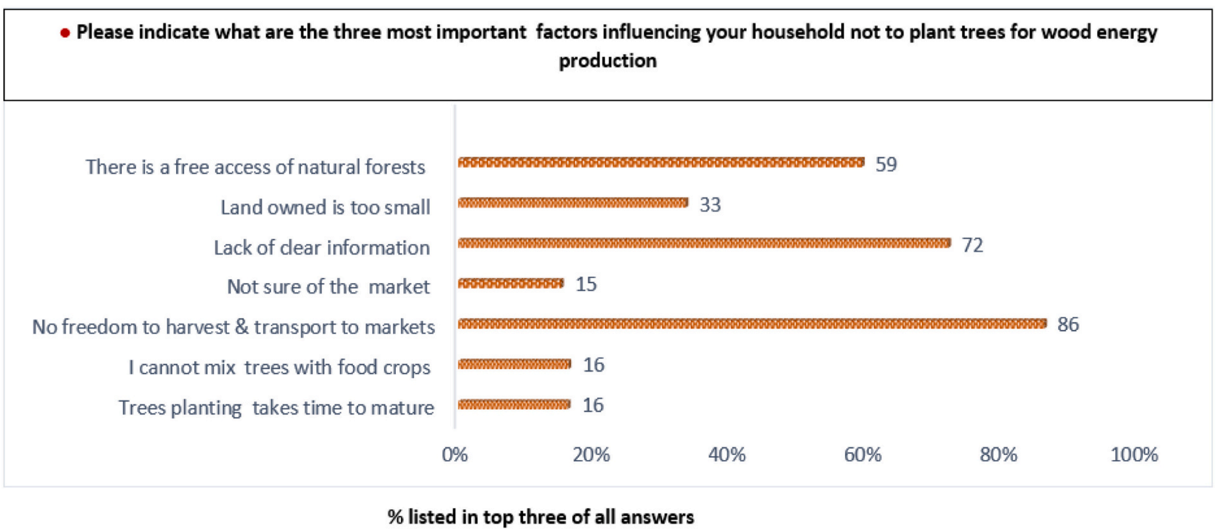

Fig. 2. Please indicate what are the three most important factors influencing your household not to plant trees for wood energy production

this (Fig. 2). In this study, we also designed the survey instrument to measure apparent perceptions of tree-planting for energy, as in Dillman (1978). We designed the instrument using existing scales that appeared to fit into our study (Ali et al., 2019). The responses were designed based on a seven-point Likert scale in which −**3** indicated tree-planting for energy is very unfavourable and + **3** very favourable, while 0 indicated indifferent or no idea. The seven-point scale was chosen in order to offer a distinct neutral point (indifferent or no idea) and to encourage respondents to sufficiently consider the choice of alternatives. We performed a simple comparison of means of household perceptions covariates to determine how the means of those who planted trees differ from those who did not. Two-sample *t*-test was used to compare continuous explanatory variables within groups (households who planted trees and those who had not); whereas a two-sample test of proportion was employed to compare dummy explanatory variables (Table 3). The test assumes that the sample comes from about a normal distribution suggesting that the difference between the means is zero. Thus, any significant difference between the groups is usually the first warning sign of selection bias if it exists (Strazzera et al., 2003). Note that explanatory variables are factors that can influence the dependent variable, whereas the dependent variable is an output that varies as explanatory variables vary. We also express these variables as $y = x\beta + \mu$, whereby the value of x is the explanatory variable and y depends on x.

3.3. Empirical model for regression analysis

The decision to plant trees involves two stages: perceiving the potential utility of planting trees and how many trees to plant. Intuitively, households will decide to plant a certain number of trees only if the utility of planting is greater than it would be otherwise. Households tend to maximize utility (ω) subject to incentives (such as low costs including cost of planting, cost due to distance to the resource or prices of fuelwood from the forest) and the choice of whether to plant depends on whether $\omega > 0$. Spatial allocation of forestry activities within one's own planted trees, open access, and reserve forests are among the directly related factors to the utility of households (Fig. 1). The forestry activities including tree-planting, cutting and collecting trees can take place in the open access forests, reserve forests and on other land. Household's optimal choice that maximizes utility when deciding whether or not to plant trees, influenced by different determinant factors, includes the distance to the forests. Because the data collected involves a choice between alternative factors through the Likert-type items and perception of tree-planting, the need for a discrete choice model and a censored regression model to correct sample selection bias becomes a central component for inference (see Wooldridge, 2010).

The data gathered through the questionnaires using the Likert scale are ordinal, such that one score of the Likert categories is greater than another but not the distance between the values, say 1, 2, 3 (Göb et al., 2007). Because of the ordinal nature of our data, we could not employ the Ordinary Least Squares (OLS) model to analyse the Likert-type data (Norman, 2010; Mudaca et al., 2015) and so the multinomial logit model and the ordered logit model were considered appropriate techniques. According to Goldstein and Hersen (1984), the ordinal responses that are determined by the latent variable with higher level properties are expected to be chosen and get higher scores than those with lower properties. The ordered logit model is often used for capturing the data being ordered as equally spaced in a meaningful sequential order like primary, secondary college and university. The ordered probit model is usually employed when the nature of the data violates the assumption of independence for irrelevant alternatives (IIA) in categorical data. However, after assessing the results of the IIA assumption, the multinomial logit model was proposed following the test that was unable to reject the IIA. In addition, a single choice reaction of perceived favourable variable asks the respondent to choose from various ordered alternatives not equally spaced in a meaningful squential, each item providing a discrete estimate of the continuous latent variable. A proper model for analysing the Likert-type categorical data with attached values not equally spaced in a meaningful squential should acknowledge the discrete nature of the responses. The multinomial logit (MNL) model is the most appropriate statistical approach for analysing such choice data (see annex B).

We employed the multinomial logit (MNL) model, using STATA statistical software, because it permits the estimation of data over more than two categories that do not contain meaningful equally spaced ordinal information. Thus, several authors have used the multinomial regression approach (Chan et al., 2019; Schildkraut et al., 2019; Prado et al., 2019; Owuor et al., 2020). However, many studies have indicated that unobserved factors due to sample selection bias may affect observed perceptions of tree-planting (Gebreegziabher and van Kooten, 2013; Turinawe et al., 2015). According to Wooldridge (2010), selection bias may arise when the sample is not randomly selected from the population. Since our data were from villages which had, or have had, active tree-planting programmes, the participation of households in our questionnaires was not decided randomly from the population of households in Tanzania. For this reason, a simple OLS can lead to substantial bias in the estimates. Furthermore, the ordinal nature of our data prevents us from using the OLS model, as previously mentioned. The employment of censoring and sample selection model is, instead, appropriate. Therefore, we employ a Heckman sample selection model to correct for this bias (Kumar et al., 2011).

The Heckman sample selection model, developed in 1974, is based on the assumption of bivariate normality (Zhao et al., 2020). The model involves two estimation approaches called the maximum likelihood estimation (MLE), and the Heckman two-step approach. Both estimation approaches correct the possible selection bias. However, studies indicate that the MLE performs better than the Heckman two-step method under a non-collinearity condition (Wolfold and Siegel, 2018). Studies indicate that when there is no exclusion restriction and when the error terms do not follow a bivariate distribution, MLE usually performs significantly better than the Heckman two-step method (Zhao et al., 2020). Thus, the MLE was employed in our study. However, we employ the Households' awareness of tree-planting programs variable as exclusion restriction when estimating our data using the Heckman model. The model corrects the endogeneity due to selection bias, treating the selection bias as an omitted variable problem (Antonakis et al., 2014). To correct this problem, the model first estimates the Probit Eq. (1) that is related to whether household planted trees or not. Second, the model estimates the OLS Eq. (2) which relates to the number of trees planted expressed as follows:

$$y_1 = Z_1\beta_1 + \mu_1 \quad (1)$$

$$y_2 = Z_2\beta_2 + \eta_2 \quad (2)$$

where y_1 and Z_2 denotes the propensity to decide whether to plant trees or not and the quantity of trees planted respectively, Z is a vector of explanatory variables and μ and η are error terms.

We then consider that the data generation is expressed by eq. 1 and 2, where y_1* and y_2* are assumed to be latent variables. In the same thinking, when the μ and η error terms are assumed to follow a bivariate distribution and be independent of Z with the mean = 0 (exogeneity), selection occurs such that observed selection occurs when $y_1 = y_1$* and $y_2 = 1$.

if $y_2^* > \tau$ and y_1 not observed when $y_2 = 0$ if $y_2^* \leq \tau$.

This tells us that when the latent variable y_2* is greater that τ (at some threshold), selection of the observation occurs such that $y_2 = 1$ and thus the latent variable y_1* be observed in y_1. Considering the assumption of the error term distribution expressed as $\mu_1 = \lambda\eta + \varepsilon$ and then plugging in the data generation equations as: $y_i = Z_i\beta + \delta\eta_i + \varepsilon_i$ this suggests that a regression of y_1 on Z_i would omit the selection bias captured in η_i. The model derives the inverse Mills ratio based on the nomality distribution property expressed as: $E\left(\frac{\mu_i}{\eta_i} > -Z\right) = \lambda(Z) = \frac{\phi(Z)}{\theta(Z)}$. We then plug the lamda (λ) in and get: $y_i = Z_i\beta + \delta\frac{\phi(Z)}{\theta(Z)} + \varepsilon_i = Z_i\beta + \delta\lambda_i + \varepsilon_i$ where ϕ and θ denote the standard normal density function and the standard normal cumulative distribution function, respectively, and β denotes a confident vector. Finally, we estimated the outcome equation y_1 on Z_i including the inverse mills ratio ($\delta\lambda$) as covariate.

4. Results

4.1. Descriptive results

Table 1 shows that, although some households plant trees as a substitute source of energy, they also extract fuelwood from the forest reserve, which means that they are no different from those who are not planting. Tree-planting and a forest policy on fixed allocation of wood for energy could be a substitute, but this has not really been addressed in the areas studied.[4]

In terms of the policy instruments under discussion, no respondent reported having fixed allotments of wood for energy, and no such system exists in the areas studied. Furthermore, our main focus turns out to be how do households perceive tree-planting for energy. As seen from the summary statistics in Table 1, the households who perceive tree-planting for energy favourably (84%) tend to obtain their energy from planted trees. Of those who obtain their fuelwood from open access sources, 28% plant trees. This percentage is higher when considering those who acquire their fuelwood from forest reserves (65%) and/or planted trees (73%). We noted that experience and education matter when deciding about where to obtain fuelwood. There is a slight difference in the mean between households with more years of education (who tend to extract energy sources from forest reserves) and those with less education (who tend to obtain energy sources from open access and planted trees).

In our study, the respondents who do not plant trees were asked to choose the three most important factors that influence them not to plant trees for fuelwood. Fig. 2 shows that the respondents could choose the three most impotant factors from seven different options. No right/

[4] Fixed allocation of wood is meant to support the general idea of forest reserves, while promoting tree-planting within a broader context provides the basis for a forest management policy. We argue that if the regulator ex-ante to tree-planting fixes a certain allotment of wood for energy and commits to not issuing additional allotments after the success of tree-planting and the benefits realized (subsidies; sell at positive Ramsey price; and creates a favourable business environment), then the incentives for households who do not plant trees will usually be smaller than optimal (depending on the opportunity cost of distance and if the cost to households exceeds the amount allocated) benefits (pBq = 0) compared with the benefits households who plant trees receive.

Table 1
Summary of descriptive statistics.

Variable	Wood energy consumption by forests sources	Reserve (57%)	Open Access (34%)	Planted (9%)
	Description of variable Label and value	$\bar{X}$	$\bar{X}$	$\bar{X}$
	Dependent variable			
Dependent variable				
PerceTreePL	Perceptions of tree planting. The answer choices ranges from Very favourable (+3) to Very unfavourable (−3)	0 0.57 (0 0.14)	0.36(0.18)	0.84(0.36)
hhplantreed	households planted trees yes = 1; No = 0 if otherwise	0.65 (0.04)	0.28 (0.05)	0.73 (0. 10)
Notreeplnted	Number of trees planted by the households	31.02 (3.65)	7.31 (2.02)	52.21 (13.79)
Explanatory variables				
PTrPlatng	Perceptions of tree-planting for wood-energy yes = 1 if a household perceived the potential in tree-planting for energy/trade; 0 otherwise	0.69 (0.04)	0.739 (0.05)	0.89 (0.07)
PwoodEBus	Perceived business environment Yes = 1 if perceived conducive; No = 0 if otherwise	0.70 (0. 04)	0.76 (0.05)	0.63 (0.11)
HHEOFA	Household involved in off-farm income activities = 1; 0 if not	0.67 (0.04)	0.53 (0.06)	0.68 (0.10)
HHsize	Household size	5.39 (0.11)	5.18(0 0.17)	5.73 (0.28)
hhedu	Highest level of education a household head attained (years	5.57 (0.36)	4.63 (0.41)	4.78 (0.76)
hhage	Age of household head in years	49.12 (1.04)	48.07 (1.45)	52.73 (2.04)
hhsex	Sex of the household head = 1 if Male; 0 otherwise	0.71 (0.04)	0.76 (0 0.04)	(0.94 (0.05)
HHorMPM	Households' awareness of tree-planting programmes = 1; 0	0.44 (0.04)	0.23 (0.05)	0.73 0.10
woodergINC	Income obtained from wood energy trade per household	1,008,681[a]	976,376.8[a]	604,778.9 [a]
LwoodergINC	Log of income generated from wood-energy trade	2.65 (0.327)	2.66(0.264	2.52 (0.225)
hhfarmsize	Farm size in acres owned by the household	5.88 (0.32)	4.44 (0.32)	7.92 (1.00)
ISFPolBFTP	If you had the right/freedom to harvest and transport the tree products from farms to the markets, would you plant trees? Yes =1; 0	0.43 (0.04)	0.34 (0.05)	0.63 (0 0.11)
ForeReVill	Is there any forest reserve near your village? (Yes = 1/No = 0)	0.81 (0 0.02)	0.47 (0.06)	0.23 (0.02)
DOCForVill	Distance to the wood energy sources from the village, (km)	1.94 (0 0.07)	6.92 (0.97)	0.5 (0.00)
Fbuffezone	Is there any allocation of a fixed amount of woodlots allowed for wood energy e.g. forest buffer zone? Yes = 1; 0 otherwise.	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Doclarrawoog	Does a clear woodfuel harvesting system exist? 1 = Yes	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
AOCCFV	Is there open access forest near you village? Yes 1; 0	0.52 (0.03)	0.73 (0.05)	0.52 0.11
hhgrsINC	Household gross income per capita (using AEU)	545,042.9 [a]	609,056.5 [a]	539,542.4[a]
LhhgrsINC	Log of household gross income per capita (using AEU)	13.16 (0.02)	13.16 (0.47)	13.10 (0.10)
Lwoodexp	Log of expenditure for wood fuel from different sources	2.83 (0.24)	2.05 (0.29)	2.55 (0.17)
hhwooderg	Do you or any member of the household engages in wood energy business (yes = 1, no = 0)	0.52 (0.11)	0.41 (0.04)	0.37 (0.034

[a] Tanzania shillings (Tshs) where 1 USD = 1620 Tshs in 2013 and the standard Dev. are in parentheses.

freedom of households to harvest and carry forest products to the market from farms (i.e., planted trees are treated the same as trees harvested from the natural forests) was the most important factor influencing tree-planting for energy, followed by lack of awareness of planting trees and the existence of fuelwood for free from the forest reserves.

The respondents who plant trees and those who do not in the study areas were asked what they expect from planting trees in the next five years (Fig. 3). Almost 43% of the respondents believe that tree-planting would only be favourable if training was given and tree seedlings were available in the village, whereas about 17% said they were unsure. The households were also asked to give their views on whether legal enforcement hinders people from planting trees for fuelwood. Almost half of the respondents (Fig. 4) said a household has no freedom to harvest on-farm tree products (e.g. in the form of charcoal) and carry them to the market. In other words, there is no difference in treatment between natural forests and planted trees in terms of transport to markets; both face harsh transportation tariffs. Note that the right to fell trees planted on households farmland and around homestead is not clearly defined in the existing forest policy of Tanzania (URT, 2002).

The results presented in Fig. 5 shows that the right/freedom of a household to cut and carry tree by-products like charcoal to the marketplace is perceived as strongly positive, followed by the availability of tree seedlings for people who do not plant trees. The respondents who plant trees were also asked about their perception of planting trees in the next five years. A majority (82%) believe that they

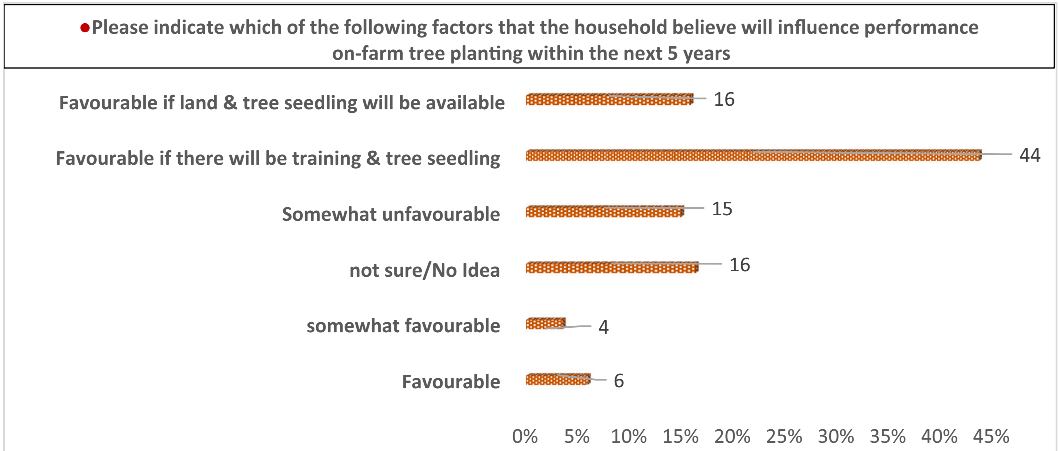

Fig. 3. Please indicate which of the following factors that the household believe will influence performance on-farm tree planting within the next 5 years

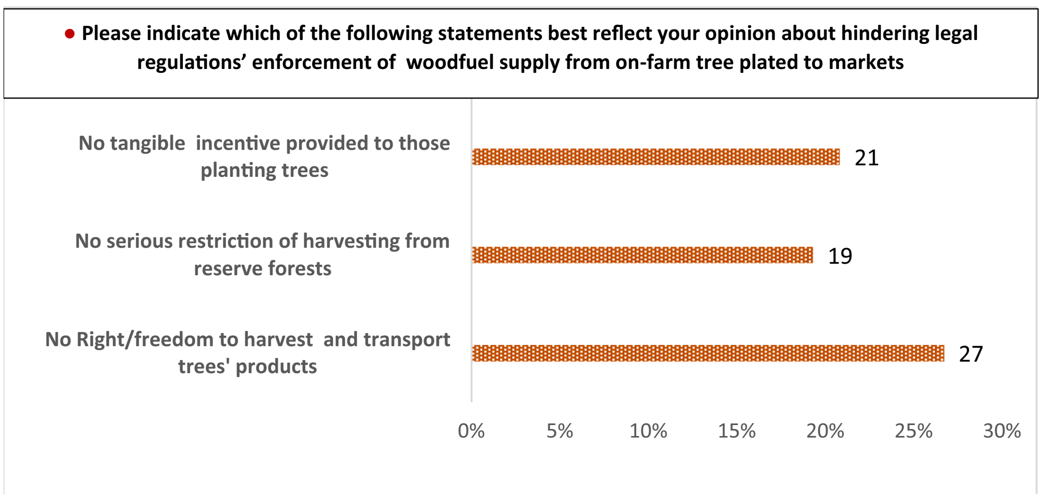

Fig. 4. Please indicate which of the following statements that best reflect your opinion about hindering legal regulations' enforcement of woodfuel supply from on-farm tree plated to markets

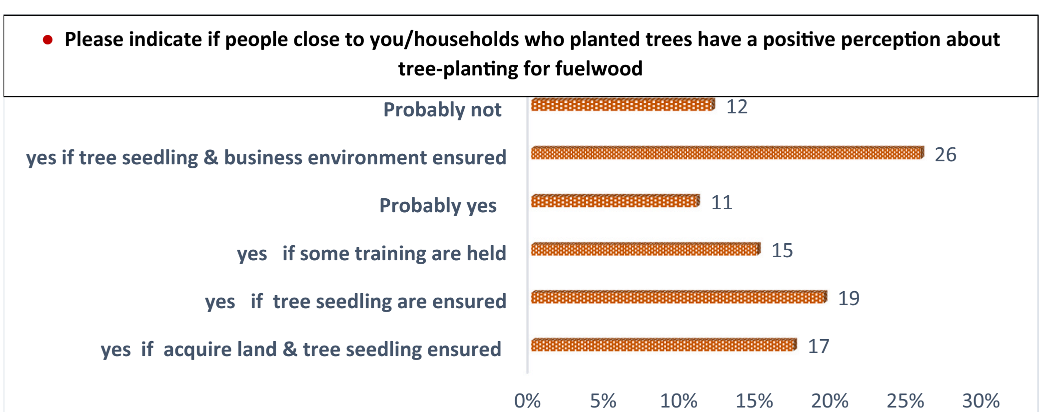

Fig. 5. Please indicate if people close to you /households, who planted trees have a positive perception about tree-planting for fuelwood

will continue to plant trees only if the freedom to harvest on-farm wood products and carry them to the marketplace is ensured by the officials (Fig. 6).

4.2. Comparison of means of households surveyed

Table 3 presents the means of continuous variables tested using a two sample *t*-test, whereas a two sample test of proportion (as alternative approach of chi-square) was employed to compare means of dummy

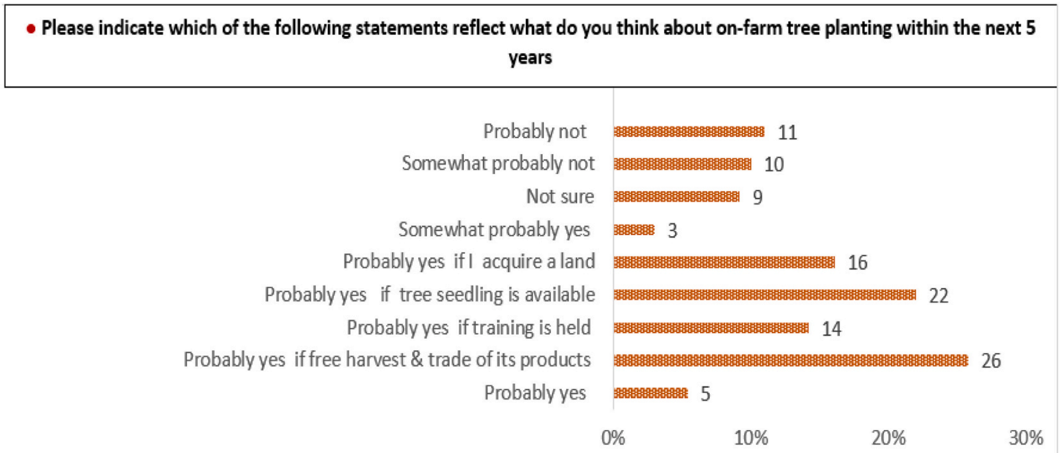

Fig. 6. Please indicate which of the following statements that reflect what do you think about on-farm tree planting within the next 5 years

variables in the two groups. The results show significant differences in means between the groups in most of the variables used in the analysis and therefore primarily justified the use of the sample selection model. Tables 3 and 4 present the variables that influence household perceptions of tree-planting as well as the intensity of perceptions in terms of the total number of trees planted. Significant chi-square statistic values for all the models indicate the existence of valuable information in the estimated regressions. Table 3 indicates the summary statistics (mean standard error) of variables employed in the empirical regression analysis.

Table 4 presents the descriptive analysis of the dependent variables used in the empirical multinomial logit regression analysis. The nominal column relates to the respondents' answers and the score column contains the numerical equivalent scores of the respondents' answers used in the empirical multinomial model (where very unfavourable = −3, unfavourable = −2, somewhat unfavourable = −1, indifferent or no idea = 0, somewhat favourable = +1, favourable = +2, and very favourable = +3). In this analysis, the results indicate the preliminary response of households on perception of tree-planting for energy on a continuum from very unfavourable to very favourable in the study areas. Somewhat favourable (30%), favourable (28%) and somewhat unfavourable (15%) compose the largest group. The first two groups partially support tree-planting for energy and the third group does not mainly favour tree-planting for energy.

4.3. Empirical results

The estimated MNL model of household perceptions of tree-planting for energy is given in Table 5. The results for the MNL show the difference in perceptions of tree-planting for energy of households in the study areas. MNL regression findings show that education of the household head, off-farm incomes, farm size and income from fuelwood have significant impacts on the perception of tree-planting for energy. On the other hand, employing the Heckman model, findings show that off-farm income of the households does not have a significant impact on household perceptions of tree-planting but has a positive and statistically significant impact on the total number of trees planted.

The MNL regression estimates show that education of the household head, off-farm incomes, farm size and income from fuelwood have a significant effect on the perception of tree-planting for energy. The off-farm income of the households does not have a significant effect on household perceptions of tree-planting but turned out to have positive, and statistically significant, effects on the total number of trees planted.

Results in Table 5 reveal that household heads who perceive the potential of planting trees for energy also perceive that they have the right/freedom to cut their on-farm wood products and carry them to the market (although the right does not exist and they had no clear information). Age of the household head, awareness of tree-planting programmes, households' farm size, expenditure on fuelwood and education level of a household head have a positive effect on the favourable perception of tree-planting for energy.

Households' awareness of tree-planting programmes enhances the likelihood of them planting trees for energy by 9.66 (favourable) times more than those who are unaware. This result further indicates that households in which at least one member is aware of tree-planting programmes are five times more likely to have very favourable perceptions of tree-planting for energy. Holding all other constant, a one-year increase in the education level of a household head significantly ($p < 0.01$) increases (by 34%) the number of households that have a positive perception towards tree-planting for enegy.

On the other hand, our results indicate several factors negatively affecting household perception of tree-planting for energy. These factors include:

- The perception of the business environment for fuelwood,
- Household perceptions about tree-planting for trade,
- Distance from the village to the source of fuelwood,
- Household size.

In general, our findings indicate that many factors influence household perceptions of tree-planting. The results further show that perceptions about the right/freedom of a household to harvest and take their tree products to the market positively influences the level of household perceptions of tree-planting for energy. However, the presence of forest reserves near the villages in the areas studied is negatively and significantly correlated with household having a favourable perception of tree-planting. A unit increase in average distance to the sources of energy (open access forests 6.9 km) significantly reduces (by 22%) the number of households that have positive perceptions of tree-planting for energy.

The positive sign of the interaction variables (education of the head of household and household planted trees) suggests that heads of households with relatively higher education levels are more likely to plant trees for energy.

The results from the Heckman model (Table 6) present the factor(s) that influence household perceptions of tree-planting and the total number of trees planted. The dependent variable for the selection equation (column IV) was coded = 1 if the households perceived tree-planting to be favourable and also planted trees, and zero if otherwise. We estimated a model with the exclusion restriction *"households' awareness of tree-planting programme variable",* assuming that this variable is likely to influence local community perceptions of tree-planting, but unlikely to influence the total number of trees planted (Puhani, 2000).[5] Thus, we estimate the variable of awareness in the probit equation and exclude it in the equation of interest (primary equation) in order to clear up any collinerality problem of the model (Leung and Yu, 2000).

In the Probit results, the factors (including the freedom to cut and transport tree products to the marketplace and the size of the farm a household owns) with a positive effect on the households ́ favourable perceptions of tree-planting all have significant impacts on the number of trees planted. However, a household's size has a negative, and statistically significant, effect on households ́favourable perceptions of tree-planting for energy.

The dependent factor in the outcome or primary equation (column II) was formed by the total number of trees planted by each household. The estimated correlation coefficient (ρ) of the model is statistically significant at $p < 0.00$ and, in the Likelihood Ratio (LR) test, $\rho = 0$ and hence rejects the independence of the two error terms in the equations. This result calls for a joint estimation of both outcome and selection equations that are important, as otherwise these equations would yield inconsistent findings. Furthermore, the inverse Mills ratio is statistically significant and justifies the OLS inconsistence, which suggests that OLS with omitted term λ (estimated selection coefficient lambda) is likely to lead into bias estimation of (β) parameter and cannot be an appropriate model where there is sample selectivity bias (Leung and Yu, 2000), thus justifying the use of the Heckman approach to our study.

The results presented in Table 6 suggest that households with more knowledge about tree-planting are more likely to be involved in tree-planting programmes than households with less knowledge. In other words, information matters in influencing household perceptions of tree-planting. Roshetko et al. (2008) also reported that information and knowledge have a strong influence on smallholder agroforestry systems. As noted earlier, the perceptions of tree-planting depend on different factors including environmental policy and characteristics of the household head.

5. Discussion

In all the models, the share of households that has favourable perceptions of tree-planting for energy is significantly associated with policy incentive-related determinants ('the right/freedom to fell trees on the farms and transport them to markets'). This could lead to a change in perception if fuelwood energy produced from a household farm or around homestead were to be included and implemented successfully in the forest policy. However, about half of the respondents interviewed said that there is no right/freedom to cut and transport tree products from farms to the marketplace, suggesting that there is no difference in treatment between households who planted trees and those who did not in terms of transport to the marketplace; both face harsh transportation tariffs. According to Jiang (2005), policy instruments first change behaviour, which then helps to alter the perception of what is "right" or "effective". We reaffirm the importance of policy instruments such as right to cut trees in enhancing tree-planting behaviour, which then raises household tree-planting perception. As seen from Fig. 2, the majority (86%) of respondents perceives that *"the right/freedom to fell trees on the farms and transport them to the market"* is important for planting trees. This suggests that this is the factor most likely (Fig. 2) to favour tree-planting for energy. However, household perceptions of planting trees for fuelwood revealed little significant effect on tree-planting in the study areas. Our results show that household perceptions of tree-planting for energy has unexpected negative coefficients but is statistically significant in all models. This latter finding contrasts with the results of Hassan et al. (2013), in which nearly 90% of the respondents positively perceived the importance of tree-planting for energy, who concluded that firewood was the prefered cooking fuel but the studied households did not have access to firewood and instead used other, inferior fuels for cooking. Our results with negative coefficients suggest that tree-planting for energy is perceived as a less potential alternative source of energy by respondents, perhaps because of restrictions and weak regulations that limit the right to use on-farm trees. Even if there is no legally announced restriction to fell trees in the areas of study, there is ground as per our results to believe that there could be a restriction to fell on-farm trees and transport its products to the market.

The study findings indicate that households who planted trees on their farms are positively and significantly correlated with their favourable perception of tree-planting for energy. In a way smilar to our research, Matta and Alavalapati (2006) and Primmer et al. (2014) discussed perception in relation to goals. The positive sign of the exogenous "households who planted trees" coefficient suggests that perceptions have the potential to better reflect the outcome of the tree-planting programmes in the area of study. This could suggest that whenever there are unfavourable perceptions of tree-planting by households, any public intervention programmes aimed to promote trees for energy will be doubtful.

In terms of trade, households who perceive tree-planting as a potentially favourable business tend to plant more trees suggesting the importance of policies empowering households and giving them clear *de jure* and de facto rights to trade in a conducive environment (with no unnecessary transportation and trade permit tariffs). In an environment with a successful monitoring strategy, households are likely to favourably perceive tree-planting as a potentially favourable business and, thus, plant more trees. This is consistent with our analytical framework which assumes that if there were a policy providing a clear right to harvest and transport planted trees, rational households would develop a favourable perception of tree-planting for energy. However, existing Tanzanian forest policies (1998), such as policy statements 9 and 14, target planting for fuelwood and trade only. In particular, the policy issues related to the transport of wood products to the markets appear to be disregarded or ignored (URT, 2002). Further, Mekonnen and Bluffstone (2008) indicate that when a policy which ensures gains from wood energy is perceived by households as a management policy instrument it reduces the risk of over-exploitation of natural forests. Our analytical model assumes that tree-planting and the policy of fixed allotments of wood are perfect substitutes, but if there is a weak or no extraction policy, the extractor will always undercut the price of products from planted trees, which drives down the price to zero. Thus, actors receive no difference in benefits from natural forests and planted trees. However, our results reveal that almost none of the households interviewed

Table 2
VIF multicolinearity test.

HHsize	1.44
hhedu	1.13
hhage	1.31
hhfarmsize	1.41
ISFPolBFTP |	1.79
HHEOFA	1.52
HHorMPM	1.75
LhhgrsINC	1.26
PwoodEBus	1.26
DOCForVill	1.82
hhwooderg	1.54
Lwoodexp	1.82
. HHorMPM ×SEX	1.46
HHorMPM ×hhage	1.39
HHorMPM ×hhedu	2.08
hhplantreed×hhedu	2.46
Mean VIF	1.67

[5] Individuals act according to their limited information. Awareness of say tree-planting is a precondition for engagement with it. One might suppose that information about tree-planting tends to result in higher perception levels, but does not necessarily have an effect on the total number of trees grown.

(Table 2) had any idea of such a system, such as the allocation of a fixed allotment of wood energy per year as outlined in the analytical framework model. The mean values of harvesting system variables in Table 2 reflect a loose forest management structure (Fagerholm et al., 2012).

In addition, the short distance travelled to harvest fuelwood in the forest reserves (on average 1.94 km) when legal sources of energy are absent, and/or when there is a loose forest management structure (Fagerholm et al., 2012) influences the perception of tree-planting. The influence in this respect is likely to be negative because the villagers near the buffer zones extracts tree produce as a function of the distance they travel into the forests (Fig. 1).

As forest-dependent households gain acess to other energy sources and gain legal title to their own planted trees, and if they are allocated a fixed allotment of trees to harvest from natural forests (Buffstone et al., 2008), they are likely to change their behaviour, which can then help alter their perception in the direction of planting their own trees and not illegally encroaching on forest reserves (Trac et al., 2007). Therefore, household perceptions and the analytical framework point to the need to incorporate households' perceived benefits and attributes in policies to promote tree-planting for energy (Karanth and Nepal, 2012). In this context, Roshetko et al. (2008) confirmed that incorporating households' and communities' perceptions in tree-planting programmes is important for all tree products, not just those for energy.

Other factors that were found to positively, and statistically significantly, influence the household perceptions of tree-planting include farm size, off-farm incomes, and education. Similarly, Kallio et al. (2010) and Sabastian et al. (2014) found that larger farms and more off-farm income are positively correlated with proactive timber management by smallholder farmers. Further, interaction between household characteristics and economic factors showed that the household characteristics significantly associated with the perception of tree-planting for energy were those relating to education and involvement in tree-planting (see Table 5). The education level of a household head increases the probability that the household has a favourable perception of tree-planting for energy. Furthermore, our findings suggest that household characteristics and other factors including farm size, age of the household head and household perceptions indeed matter in the decision to plant trees and the number of trees planted for energy.

The positive and significant coefficient for the age of the household head suggests that perceptions of tree-planting for energy vary across respondents' age, whereby the experience of the household head tends to affect its perception of tree-planting. This finding is consistent with previous studies which found that the experience of the household head of agricultural practices increases the likelihood of the household planting trees (e.g. Deressa et al., 2009). However, the negative, and statistically significant, impact of a household's size on favourable perceptions of tree-planting for energy suggests that less land area is set aside for tree-planting as the size of the family increases. Furthermore, large family sizes in households suggest having more labor force. Because of free or weak enforcement to control encroachment to the forest reserve, household heads tend to engage the available labor force in collecting fuelwood. Due to the existence of forest reserves accessed for free, the opportunity cost of gathering firewood is low. Therefore, the probability of tree-planting for energy decreases with an increase in household size.

In a way similar to our findings, Matta and Alavalapati (2006) found that the respondents' awareness variable has a statistically substantial impact on household perceptions of tree-planting. Our findings, therefore, suggest that awareness matters in the decision to plant trees. It is clear from our results that when a household gets informed about the benefits of tree-planting programs or the country's policy that could provide incentives on their favour, it is more likely to alter their perceptions towards tree-planting. Holding all other factors constant, a unit increase in awareness on tree-planting increases the log-odds of highly favoring tree-planting to unfavourable in all models (Table 5) except that they differ in the level of significance and coefficients.

Table 3
Comparison of means by groups of households planted trees in areas studied.

Variables	*Households plantedtrees*	*Householdsnot plantedtrees*	*Difference* ($\mu_0 - \mu_1$)	
	Mean (μ_1)	*Mean* (μ_0)	*t − stat.*	*ρ − value*
HHsize	5.21(0.136)	5.44 (0.123)	0.7892	0.2155
hhedu	5.52(0.361)	4.78(0.372)	−1.397	0.0820
hhage	51.1(0 0.973)	46.6 (1.273)	−1.4218	0.0045
PerceTreePL	0.99 (0.137)	0.25(0.167)	−3.4643	0.000
PTrPlatng	0.85 (0.034	0.58((0.051)	4.5324†	0.000
ISFPolBFTP	0.69 (0.044)	0.11(0.032)	10.4548†	0.000
HHEOFA	0.69(0.044)	0.55 (0.051)	2.1415†	0.0045
HHorMPM	0.93(0.025)	0.02(0.015)	12.8300†	0.000
LwoodergINC	2.21 (0.280)	3.01(0 0.326)	1.8686	0.0316
PwoodEBus	0.71(0 0.043)	0.72 (0.046)	−0.0757†	0.4699
DOCForVill	5.91(0.819)	8.17(0.958)	−1.8055	0.2862
hhwooderg	0.37(0.046)	0.473(0.052)	−1.5269†	0.0642
ForeReVill	0.84 (0.035)	0.784.042	−1.0758†	0.2834
hhfarmsize	6.84(0 0.363)	4.11(0.247)	−5.9912	0.0000

Standard errors are in the parentheses whereby *** indicates statistical significance at the$\rho < 0.01$,
** indicates statistical significance at the $\rho < 0.05$,and * indicates statistical significance at the $\rho < 0.1$.
†indicates z value.

Table 4
Perceived favourable of tree-planting for wood energy production in the areas studied.

Choice set	Dependent Variables			
	Probability of best alternatives	Measurement scale	Response Frequence	Response percetage
1	Very unfavourable	−3	10	4.95
2	Unfavourable	−2	11	5.45
3	Somewhat unfavourable	−1	31	15.35
4	Indifferent/ no idea	0	20	9.90
5	Somewhat favourable	1	60	29.70
6	Favourable	2	56	27.72
7	Very favourable	3	14	6.93

6. Conclusions

This paper has analysed household perceptions of tree-planting for energy and identified factors influencing these perceptions. Our results suggest that household tree-planting for energy is not only driven by awareness but is also influenced by perceptions, legal and economic incentives. Although we do not question the right of households to plant trees in their land, we have highlighted the problem of the right to fell trees on their farms and transport them to the market place while this is not conferred in the existing policy structure. This implies that the right of use of on-farm trees planted by individual households around their homestead has been ignored in the forest policy, in turn leading to difficulties in the implementation of the existing policy. Not surprisingly, the results suggest that households who perceive tree-planting favourably also do plant trees for wood energy. The right/freedom to fell on-farm trees and transport them to the marketplace, awareness of tree-planting programmes, the average farm size and education are factors positively and significantly influencing households ́ favourable perceptions of tree-planting for energy. Short distance to the forest reserves, age of the household head and the perceived business environment for fuelwood are factors negatively and significantly correlated with households favourable perceptions of tree-planting for energy. This implies that the natural forests as a source of fuelwood are likely to

Table 5
Multinomial logit estimates of household perception of tree planting in the area of study.

Explanatory variable	Very unfavourable	Unfavourable	Somewhat unfavourable	Somewhat favourable	Favourable	Very favourable
	Column (1)	*Column (2)*	*Column (3)*	*Column (4)*	*Column (5)*	Column (6)
Households Factors						
HHsize	0.63 (0.31)**	−015 (0.26)	−0.03 (0.16)	−0.37 (0.15)***	0.14 (0.16)	−0.01 (0.19)
hhedu	−0.07 (0.94)	−0 0.25 (0.12)**	−0.20 (0.06)***	−0.03 (0.05)	0.13 (0.06)**	0.34 (0.08)***
hhage	−0.11 (0.04)***	−0.01(0 0.03)	0.01 (0.02)	0.01 (0.02)	0.05 (0.02)***	0.04 (0.02)**
Economic factors						
hhfarmsize	−0.20(0.16)	−0.71 (0.21)***	0.05 (0.06)	−0.01(0.05)	0.12 (0.05)***	0.13 (0.06)**
PTrPlatng	1.20 (0.68)	1.30 (0.77)	0.89 (0.34)	−0.51 (0.17)**	−0.54 (0.20)*	-2.85 (1.61)**
ISFPolBFTP |	−17.59 (1.05)	−14.37 (12.15)	−1.23 (0.55)***	0.67 (0.48)*	2.67 (0.48)***	1.39 (0.59)***
HHEOFA	−1.61 (0.01)*	0.59 (1.28)	−1.15 (0.48)***	1.46 (0.44)***	0.94 (0.44)**	1.12 (0.54)**
HorMPM	−19.17(18.64)	−15.76 (27.35)	−8.22 (2.59)***	9.66 (2.45)***	2.75 (3.30)	4.59 (4.17)*
LwoodergINC	−3.99 (1.21)***	−3.23 (1.15)***	−0.15 (0.60)	−0.71 (0.49)	1.05 (0.52)**	0.59 (0.58)
PwoodEBus	−2.19 (0.76)	1.23 (0.77)*	0.59 (0.54)	−0.96 (0.43)**	−1.02 (0.44)***	−1.18(0.53)**
DOCForVill	0.22 (0.04)***	0.21 (0.04)***	0.08 (0.03)***	0.02 (0.03)	0.02 (0.029)	−0.06 (0.03)**
hhwooderg	1.50 (1.10)*	−1.08 (1.29)	1.51 (0.50)***	−0.44 (0.44)	−0.47 (0.44)	−2.61 (0.59)***
Lwoodexp	0.02 (0.16)	−0.04 (0.17)	−0.25 (0.09)***	0.51 (0.09)***	0.35 (0.09)***	0.30 (0.11)***
Interaction of factors						
HHorMPM ×hhage	−0.01 (0.07)	0.10 (41.33)	−0.10 (0.04)***	0.16 (0.03)***	0.03 (0.04)	0.09 (0.04)**
HHorMPM ×hhedu	−4.74 (3.06)	0.36 (11.73)	−0.01 (0.39)	−0.52 (0.40)	0.40 (0.23)**	−0.28 (0.550)
hhplantreed ×hhedu	0.26 (0.64)	−1.65 (12.71)	0.34(0.21)*	0.51 (0.39)	0.41 (0.20)**	0.49 (0.21)**
intercept	47.9 (16.43)***	41.31(15.69)***	2.97 (8.31)	11.81 (6.86)**	15.73 (7.28)**	−4.71 (8.03)
LL (0)	−1400.21					
LL (*B*)	-977					
AIC	2136. 29					
BIC	−363.67					
McFadden's R^2	0.647					
Log-likelihood ratio	−977.14					

Standard error in parentheses set initial value of corr and std diviation and ***p < 0.01, ***p* < 0.05, **p* < 0.1.

Table 6
Results of full-information maximum likelihood estimation.

	Number of trees planted		*Households' perceptions of tree planting*	
Explanatory variable	*Regression*	*Marginal effects of number of trees plated*	*Regression*	*Marginal effects of tree plating*
Column I	*Column II*	*Column III*	*Column IV*	*Column V*
	β_1	β_1	β_2	β_2
ISFPolBFTP	32.72(9.623)***	0.602(0.071)***	2.870(1.020)***	0.602(0.071)**
hhfarmsize	1.794(0.978)*	0.062(0.017)***	0.220(0.126)*	0.062(0.017***
HHEOFA	30.41(8.361)***	0.044(0.122)***	−1.340(0.893)	0.044(0.122)
PTrPlatng	−6.76(2.882)***	−0.013(0.030)***	0.119(0.155)	0.013(0.030)
hhwooderg	51.289 (135.19)	0.901(0.272)	−0.452(2.398)	0.901(0.272
PwoodEBus	−16.92(7.714)**	−0.078(0.110)**	−0.819(0.620)	-(0.078(0.110)
HHsize	−13.236(12.338)	−0.425(0.205)	−1.863(1.09)*	−0.425(0.205)**
HHsizesq	0.692(1.135)	0.033(0.186)	0 0.138(0.109)	0.033(0.018)
LhhgrsINC	3.002(11.174)	0.080(0.133)	−0.456(0.734)	0.080(0.133)
LwoodergINC	−8.648 (22.482)	−0.250(0.215)	0.181(0.394)	−0.250(0.215)
hhedu	−0.284(0.129)	−0.076(0.033)	−0.284(0.224	−0.076(0.033)
hhedusq	0.026(0 0.009)	0.08 (0.003)	0.026(0.019)	0.008(0.003)
HHorMPM			4.771(1.152)***	0.906(0.062)***
intercept	36.751(160.712)		7.896(10.871)	
ρ	−0.908(0.457)**			
σ	3.507(0.066)***			
Heckman'sλ	−24.03 (7.549)***			
Wald restχ^2(13)	125***			

Wald test of independent equations ($\rho = 0$): χ^2 (1) = 5.29, probability $>\chi^2 = 0.0246$ Note: standard errors are in parentheses and.
***, **, * = Significant at 0.01, 0.0 5, and 0.1 probability levels, respectively.

continue being vulnerable to deforestation.

Our findings have the broad policy implication that a flexible extensive-minded approach in developing policy is required, accepting villagers around the forest as nature-based consumers whose daily survival depends on the forests for energy use and income. We highlight the factors that policies should target to enhance household tree-planting. For example, interventions that support the right to fell trees planted on-farm or around the homestead, perceptions of tree-planting, incentives for households who plant trees such as subsidies or refunds for those who plant trees, would promote tree-planting. Our findings are relevant to forest policy intervention suggesting that policy in a regional context should avoid general statements and one-fits-all approaches in protecting forests, for example regarding the definition of a "forest" in the Tanzanian Forest Act of 2002. Our findings also reveal that there is no difference in treatment between households who plant trees and those who fell trees in natural forests; both face the same restrictions on the *de jure* right/freedom to cut down trees on their farms and transport them to the marketplace.

Furthermore, our results reveal that a better policy related instrument tend to result in more favourable perceptions of tree-planting by households and vice versa. For example, a policy instrument that provides an incentive for households who plant trees would enhance the household perception of tree-planting, such as the freedom to sell tree products from their farms as well as subsidies and/or licenses for those who plant trees. If such a policy were to exist, it would be an established structured system concerning incentives on felling one's own trees and penalties or tax sanctions enforceable for those who could encroach on forest reserves. But as of now, it indirectly implies that there are no penalties that work; households around the forests usually encroach to get their daily energy demand for cooking. As noted earlier, the issue of penalties may apply to protect the extraction of the forests but appears not enforceable to villages around the forest reserves. That is because the existing forest policy does not directly recognize villagers around the forest reserves as nature-based consumers whose daily fuel consumption and income depends on the forests.

This paper suggests that if policy makers are concerned about tree-planting as a source of energy for forest-dependent households, the implementation of tree-planting programmes needs to take into account household perceptions of tree-planting, rather than relying on tree-planting campaigns alone. Our analysis demonstrates that unless the constraints of economic policy instruments perceived by households of tree-planting are tackled, the strategy aimed at promoting tree-planting as a contribution to households' livelihoods will be of doubtful value.

The main limitations of the chosen approach is related to the study of perceptions as such. Studies of perceptions implies a certain uncertainty; are the perceptions really representing what would happen also in actual decision-making. However, in real world situations it is important to study also perceptions since they, despite their uncertainty, in many situations where large scale experiments are impossible and/or unethical to carry out, provide the best understanding of how decision-makers would chose to decide and, thus, knowledge about perceptions constitutes an important contribution both to scientific knowledge and as inputs to policy-making.

Finally, we would like to continue the research along two different lines: 1) by following the same methodlogy as in the submitted paper but extend the study to other areas (with slightly different conditions); and 2) if possible, follow the impact of changing policies in the field to learn more about if the results provided by the investigated perceptions also holds under a changing policy environment.

Declaration of Competing Interest

There are no conflicts of interest.

Annex A: The theoretical model framework comprises extractors and regulators of forest products

The equilibrium of the model is characterised by allocating forest areas as buffer zones (see Fig. 1) to households for extraction and factors in such a way that the endogenously determined prices clear all their relevant markets and households realise zero economic profit. For clarity, the equilibrium conditions must be satisfied in the following subsections: (i) consumer/firm equilibrium problem in the households that do not plant trees; (ii) consumers/firms equilibrium problem in the households that plant trees; and (iii) equilibrium problem of the social planner, whose action is to determine the optimal allocation of forest resources.

(i) Wood-energy allocation to, and utility of, a household that does not plant trees.

We assume that the regulators' problem is to allocate some forest areas as buffer zones for free extraction and that there is constant utility across time in the conceptual model, which permits other factors to influence household utility.

(a) Suppose the households in particular villages are allocated by the regulator a fixed amount of H wood energy to harvest for free in a year. The allocated wood is assumed to be sufficient for domestic use for a year and the regulator fixes the allocation to be harvested once a month in quantity (q) decided by a household. Therefore, the household can use the extracted wood in any way and can even trade it in the market. But the quantity q_i of wood extracted should not exceed the quantity (q) allowed per month. We assume that fixed days are allowed for harvesting and transporting the resource. Hence, the quantity allocated per month is distributed throughout the year to meet that fixed amount $H$and this is given as:

$$\sum_{i=1}^{N} q_i \leq H \text{ per year } (i = 1\ldots.0.12 \text{ months})$$

(b) We assume that a household that does not plant trees will maximize utility or benefits subject to costs$c(d,q)$, a function of distance to the forests where collection is allowed for free and transportation costs for the quantity q of wood harvested. Transportation costs (even the cost of carrying wood lots on their heads based on monetary terms) depend on distance. If households exceed the quantity q_i (for free) and are caught, they will pay Bq as tax set by the regulator for at least one year, depending on how much the allowable quantity is exceeded, and they will no longer be allowed to harvest for free for such a period of time. Thus, households will maximize utility as $Maxpq$ s.t $c(d,q)$, where $p$is the market price of the wood extracted and Bq is the benefit gained if not caught. The problem for the household will be to minimize the cost and net spending of the wood allowed for energy. Therefore

$$Maxpq$$

S. t $c(d,q)$
Bq if exceeds $H \geq (\Sigma q_i)$

$$L = c(d,q) + \lambda \left[H - \left(\sum_{i=1}^{N} q_i - d - Bq \right) \right] \quad (1)$$

F.O·C (first-order condition) W.r.t d & q

$C_d = \lambda$ if the household does not exceed the amount allocated.[6] λ shows the cost of the estimated travel distance (d) to the forest. If the amount harvested exceeds the amount allocated, the costs become $C_q = \lambda + \lambda Bq$. In this situation, the welfare of households will decline at the rate at which the amount of wood exceeds the allocation H. Thus, rational households would choose not to exceed the fixed amount H. The cost is assumed to be higher for households further away from the forest. Therefore, the conceptual model asserts that, if there were a policy that could reduce the distance and provide a clear right to harvest planted trees, this could provide heterogeneous incentives and rational households would develop a positive perception of tree-planting.

(c) Consider the regulation or policy strategies aimed at enhancing factors that may influence household perceptions of tree-planting, such as business-oriented programmes, a conducive environment for wood energy businesses and subsidies for tree-planting. These factors may directly or indirectly influence households' perceptions. We model this using subsidies or refunds and tax policy that are assumed to positively influence household perceptions of tree-planting. Thus, the regulator is likely to influence household perception significantly, say, offering $v(q)$ so that the value increases with the total number of trees planted. This value takes the form of subsidies or refunds, expressed as

$$v\sum q_i f(X_i) \tag{2}$$

where X_i stands for other incentive variables as exogenous factors apart from subsidies or refunds that may positively influence households members' perceptions. Households who exceed the amount of wood allocated per year could be taxed, so that the value of tax = the value of subsidies refunded to households planting trees. This is given as

$$v(q) = \lambda + \lambda Bq \tag{3}$$

A household incurs a cost from tax, which shapes its behaviour so as to keep within the limit of the amount of wood allocated for free. Thus, equilibrium should be maintained so that the cost function of distance $c_d = \lambda$ holds for a household that does not plant trees and keeps within the limit.

Following incentives such as subsidies for those planting trees, the cost of production $c(d,q)$ will be lower, so that $\lambda \geq C_q$. Therefore, the regulator will be satisfied only if the costs incurred by households planting trees are less than the shadow price incurred by households who do not plant trees, which is

$$c_q \leq \lambda \leq \lambda Bq \tag{4}$$

This conceptual model assumes that the market price or shadow price of the benefits for those who plant trees is induced by the price policy instrument.

(ii) Profit or utility maximization of households who plant trees

Consider households who perceived tree-planting for wood energy as a feasible and profitable activity. They tend to maximize profits or utility (ω) subject to incentives less costs. Because we do not know which factor influences how much households value tree-planting, we differentiate ω with respect to d and vq (incentive), given as;

$$\omega = pq - c(d,q) + v(q) \tag{5}$$

We assume that planted trees are spatially located with estimated zero travel distance.

$$\text{F.O·C } \omega_d : -c_d \tag{6}$$

$$\omega_q : p - c_q + v_q \tag{7}$$

Given our assumption that planted trees are spatially located with estimated zero travel distance, we notice that eq. (6) yields a negative result, which implies that the welfare of a household deteriorates with distance.

Other factors held constant, the positive sign of vq in eq. (7) suggests the value of the incentive enjoyed by households planting trees. Subsidies plus many other attractive factors, for example, a conducive market environment for planted tree products, are likely to increase perceived utility, and result in creating a positive perception of planting trees for wood energy.

(iii) Social planner or the forests' regulator

The regulator's problem is to allocate the forest cover sustainably across time in such a way that the cost of suffering from the decline in forest cover and of monitoring forest reserves are minimized. This is given as $L = c(q) + p\left[H - \left(\sum_{i=1}^{N} q_i + Bq\right)\right]$

F.O·C

$$C_q = p + pBq$$

where $p = \lambda$ is the shadow price or cost as a constraint of harvesting or extracting a greater quantity of the resource than is allocated for free. The social planner would choose positive optimal cost of wood extraction $pBq > 0$ compared with $pBq = 0$ when households decide individually.

[6] FOC states that the household selects the optimal level of wood it is allowed to extract (q) given the estimated travel distance (d) to the forest in order to minimize the net cost by equating the marginal utility or benefit of an extra unit of wood extracted to the marginal cost and if it exceeds the quantity allowed the cost goes up more than its optimal level. The lambda (λ) shows the price or cost of the estimated travel distance (d) to the forest, which a household would always incur

Interaction between the decisions of extractors and forest regulators on wood energy allocation

In this model FOC implies that actors select their optimal level of output to maximize net profits or utility by equating the marginal benefit of an extra unit of output/quantity to the marginal cost. In this case, the forest regulator acts as a Stackelberg leader and considers the best response function of the extractor in determining the policy strategy aimed at enhancing factors that may influence household perceptions of tree-planting while the extractor's best response function is to find wood energy at minimum cost that provides the highest perceived net benefits from forest resources.

Annex B: Empirical models

Multinomial logit (MNL) is a discrete choice model (random utility model) that provides the probability of individual household i choosing an alternative j from a set of mutually exclusive and collectively exhaustive alternatives C_i. The modelling of individual household choice behaviour involves two stages: first, choosing a set construction from which a researcher could generate a set of 1 to 5 or 1 to 7 points; and second, choosing from a generated choice set of all possible alternatives. The alternative choices available to an individual household are assumed and treated as an observable binary variable so that an alternative could or could not be available (Paleti, 2015). The perceived utility benefit that influences household choice for each respondent is expressed as

$$U_{ij} = V_{ij} + \eta_{ij} \tag{8}$$

Where U_{ij} is individual household j's utility of choosing alternative j, V_{ij} stands for an indirect utility in choice set C and η_{ij} is a stochastic error that represents an unobservable latent variable that influences household choice.

A MNL regression model represents the probability of selecting an alternative from a possible set of alternatives. The multinomial logit model is expressed as

$$p_{jc} = \frac{e^{\omega V_{jc}}}{\prod_{k=1,K} e^{\omega V_{kc}}} \tag{9}$$

Where p_{jc} stands for the probability of choosing alternative j from the C^{th} choice set containing K possible alternative choices, while ω is a scale parameter and is assumed to be one. Consider the probability that a particular individual household made a choice in favour of option j in the choice set coded from 1 to 7 rather to any possible alternative k, then the expression can be written as,

$$p_{jc} = pr\left[V_{jc} + \eta_{jc} > V_{jk} + \eta_{jk}; \forall k \in C\right] \tag{10}$$

In order to derive an explicit expression of indirect utility function, V_{jc} can be calculated as

$$V_{jc} = \sum_{k=1,K} \beta_k x_{jk} \tag{11}$$

Where x_{jk} is the explanatory variables of alternative j in choice set k and β is the relative utility weight associated with the chosen variable (Ben and Lerman, 1991). To estimate β parameters, the maximum likelihood estimation approach is employed whereby the likelihood function of the household i's utility of choosing alternative j associated with a chosen variable q is expressed as

$$Q = \prod_{i=1,I}\prod_{q=1,Q}\prod_{j=1,J} p_{jc}^{Y_{jci}} \tag{12}$$

Where $Y_{jci} = 1$ if an individual household i chooses alternative j in a choice set C, and 0 otherwise.

We calculated the β parameters in the sample data using the maximum likelihood estimation procedure.

Before the estimation of the model we tested multicollinearity and variance problems as shown in Table 2. The results show independent values lower than 10 (Table 2), and so the hypothesis of multicollinearity was rejected. Heteroscedasticity hypothesis was tested using the Breusch–Pagan test and found a chi-square of 63.85 and a p value of 0.0000 and therefore the null hypothesis of homoscedasticity was rejected at the 99% level of confidence. The goodness-of-fit statistics were also calculated as detailed in Table 5 where

McFadden's R^2 was found to be 0.64, suggesting that the estimated MNL model fits the empirical data (household choice) better, which implies that the approximate 65% variation in the dependent variable is explained by the MNL model. The log likelihood ratio was estimated to be −977.14 with a $\chi^2 = 846$ corresponding to a p value $= 0.01$, suggesting the model has strong explanatory power and the Akaike Information Criteria (AIC) were also >0, implying that the empirical data fits the MNL regression model correctly. A difference of −363.67 in *BIC* provides very strong support for the MNL model and so it can be concluded that the statistical test executed in this analysis favours the use of the MNL regression model.

Although MNL fits the empirical data correctly and was employed to determine the factors that influence individual household choice of either favoring tree-planting for energy or not, the model is based on the assumption of the independence of irrelevant alternatives (IIA) across outcome variables (Hausman and McFadden, 1984). This assumption means that the probability of choosing between alternatives only depends on the perceived alternative choice that influences tree-planting for energy. To verify this assumption of IIA, we performed the Hausman specification test to check the validity of the assumption. A $\chi^2_{0,\ 01}$ of 19.93 was found for the MNL model when one choice alternative was normalized, which is usually referred to as the "reference point," or the "base category." In this case our category Indifferent/no idea was used as the reference state from the choice set. In this analysis, we failed to reject the IIA at 1% significance level and accept the null hypothesis, i.e. the IIA hypothesis is confirmed. Thus, it is appropriate to use the multinomial logit model.

The Heckman's sample selection model assumes that there exists a latent variable which represents the perception of tree-planting for energy in the area studied (Tessema et al., 2013; Amare et al. 2016).[7] The model is expressed as

$$y_i^* = X_i^{\prime}\beta + \varepsilon_{1i} \tag{13}$$

Where y_i* is the latent variable for the *i*th observation, y_i is the observed variable, X_i is a vector of explanatory variables, ε_i is the error, and β is the parameter estimate of explanatory variables. In the model (eq. 14) only the binary outcome executed by the probit model in the selection equation is observed as

$$y_i(\text{probit}) = y^* \text{ if } y_i^* > 0 \ (X_i\lambda + \varepsilon_{2i} > 0) \tag{14}$$

$$\text{otherwise } y_i(\text{probit}) = 0 \text{ if } y_i^* > 0 \ (X_i\lambda + \varepsilon_{2i}) \tag{15}$$

y_i(probit) stands for whether a household perceived tree-planting for energy is favourable or not. X_i is a vector of explanatory variables, which consists of several factors that are assumed to affect perception, λ is the parameter estimate, ε_{2i} is the error term and ε_{1i} and ε_{2i} (corr (ε_{1i}, ε_{2i})) are error terms, which are assumed to be uncorrelated with X_i and are identically distributed with zero mean and variance one ($\varepsilon_i \sim N(0,1)$). The OLS estimates of eq. 7 of interest are theoretically subject to downward selection bias. Where $y_i > 0$, the model is expressed as:

$$y_i = X_i^{\prime}\beta + E\left\{\frac{\varepsilon_i}{y_i^*} > 0\right\} + \upsilon_i = X_i^{\prime}\beta + E\left\{\frac{\varepsilon_i}{\varepsilon_i} > -X_i^{\prime}\beta\right\} + \upsilon_i \tag{16}$$

Where υ_i is uncorrelated with ε_i and $E\left[\frac{\varepsilon_i}{y_i^*} > 0\right]$. OLS bias comes from the correlation between the ε_i and $-X_i^{\prime}\beta$ terms in the equation for y_i*. In OLS, the term $E\left[\frac{\varepsilon_i}{y_i^*} > 0\right]$ is usually omitted and leads to bias and inconsistency of the β coefficient.

In summary, the first stage of the Heckman model is the selection model given by the probit model (eq.14), which represents the perception of tree-planting for energy. The second stage is the outcome model (primary eq. 13), which represents the total number of trees planted and is conditional upon whether tree-planting has been positively perceived by households or not. The Heckman model is the correct model to use as *a* de facto default when values are clustered at zero due to selection bias (Wooldridge, 2010).

Annex C: Questionnaire

HOUSEHOLD QUESTIONNAIRE FOR HOUSEHOLDS TREE-PLANTING FOR ENERGY IN VILLAGES, TANZANIA
(The main Section of the Questionnaire)

1. Household Identification
2. Characteristics of the Households
3. Socio-Economic Status of the Households
4. Household Tree-Planting on Own Farmland in Tanzania
5. Markets for Forest and Trees-Planted Products
6. Charcoal Production for Sale or/and Home Use

Annex D: Ethical approval and consent granted prior to data collection

Households who participated in the study were briefly informed about the purpose of the research before data collection to get their consent. In Tanzania, verbal consent from research participants in the study areas is practical. Usually, universities or research institutions provide a research clearance letter to be submitted to the regional commission where the study intended to take place, and then after the information gets communicated to the local authority. After submission of the letter to the local authority in the areas of data collection, one can now be allowed to meet with participants. The University of Dar es Salaam had provided the approval of this study with the research clearance letter-number AB3/12(B) on behalf of the government. The Coast and Morogoro regions also approved the research in their respective administrative units and provided letters with reference number FA.221/265/01/233 and AB.175/245/01/159, respectively. The consent of the household who participated in our study was verbally agreed.

[7] We use information from the study by Tesfaye et al. (2011) to determine the probability and the extent of tree-planting conditioned on local perceptions that lead them to choose whether to plant trees. In this case, we differentiate four categories, each of which takes the value of 1 or 0: we coded very favourable =1 if ranked +3; 0 otherwise, favourable =1 if ranked +2; 0 otherwise, somewhat favourable =1 if ranked +1; 0 otherwise), somewhat unfavourable =1 if ranked −1; 0 otherwise, unfavourable = 1 if ranked −2; 0 otherwise, and very unfavourable =1 if ranked −3; 0 otherwise. It follows, however, that, if $y_i^* > 0$ then $y_i > 1$ (+ perceived planting) = $y_i^* = x_i^{\prime}\beta + \varepsilon_i$ and if $y_i^* \leq 0$ then the households negatively perceived tree-planting for energy.

References

Ali, G., Yan, N., Hussain, J., Xu, L., Huang, Y., Xu, S., Cui, S., 2019. Quantitative assessment of energy conservation and renewable energy awareness among variant urban communities of Xiamen, China. Renew. Sust. Energ. Rev. 109, 230–238.

Amare, D., Mekuria, W., Twold, T., Belay, B., Teshome, A., Yitaferu, B., Tessema, T., Tegegn, B., 2016. Perception of local community and the willingness to pay to restore church forests: the case of Dera district, northwestern Ethiopia. Forests, Trees and Livelihoods 25 (3), 173–186.

Antonakis, J., Bendahan, S., Jacquart, P., Lalive, R., 2014. Causality and endogeneity: Problems and solutions. In D. V. Day (Ed.), The Oxford handbook of leadership and organizations. Oxford, England: Oxford Library of Psychology 1, 93–117.

Assefa, E., Bork, H., 2014. Deforestation and forest management in southern Ethiopia: investigations in the Chencha and Arbaminch areas. Environ. Manag. 53 (2), 284–299.

Ben-Akiva, M., Lerman, S.R., 1991. Discrete Choice Analysis: Theory and Application to Travel Demand. The MIT Press, Cambridge, Massachusetts.

Bennett, M.T., 2008. China's sloping land conversion program: institutional innovation or business as usual? Ecol. Econ. 65 (4), 699–711.

Bidogeza, J.C., Berentsen, P.B.M., Graaff, J., Oude Lansink, A.G.J.M., 2009. A typology of farm households for the Umutara Province in Rwanda. Food Security 1 (3), 321–335.

Blayac, T., Mathe, S., Rey-Valette, H., Fontaine, P., 2014. Perceptions of the services provided by pond fish farming in Lorraine (France). Ecol. Econ. 108, 115–123.

Blomley, T., Pfliegner, K., Isango, J., Zahabu, E., Ahrends, A., Burgess, N., 2008. Seeing the wood for the trees: an assessment of the impact of participatory forest management on forest condition in Tanzania. Fauna Flora Int. Oryx 42 (03), 380–391.

Brown, J., Beatty, G., Cassidy, E., Finlay, C., McKendrick, L., Montgomery, W., Reid, N., Tosh, D., Provan, J., 2015. Lack of genetic structure and evidence for long-distance dispersal in ash (Fraxinus excelsior) populations under threat from an emergent fungal pathogen: implications for restorative planting. Tree Genet. Genomes 11, 53.

Buffstone, R., Boscolo, M., Molina, R., 2008. Does better common property forest management promote behavioral change? On-farm tree-planting in the Bolivian Andes. Environ. Dev. Econ. 13 (2), 137–170.

Chan, E.T.H., Schwanen, T. and Banister, D. (2019). The role of perceived environment, neighbourhood characteristics, and attitudes in walking behaviour: evidence from a rapidly developing city in China. Transportation (2019). https://doi.org/10. 1007/s11116-019-10062-2.

Chidumayo, E.N., Gumbo, D.J., 2013. The environmental impacts of charcoal production in tropical ecosystems of the world: a synthesis. Energy Sust. Dev. 17 (2), 86–94.

Clausen, A.R., 1977. The accuracy of leader perceptions of constituency views. Legis. Stud. Q. 2 (4), 361–384.

Coulibaly-Lingani, P., Tigabu, M., Savadogo, P., Odén, P.-C., 2014. Participatory forest management in Burkina Faso: Members' perception of performance. J. For. Res. 25 (3), 637–646.

Deressa, T.T., Hassan, R.M., Ringler, C., Alemu, T., Yesuf, M., 2009. Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. Glob. Environ. Chang. 19, 248–255.

Dillman, D.A., 1978. Mail and Telephone Surveys: The Total Design Method. John Wiley & Sons, New York.

Fagerholm, N., Käyhkö, N., Ndumbaro, F., Khamis, M., 2012. Community stakeholders' knowledge in landscape assessments – mapping indicators for landscape services. Ecol. Indic. 18, 421–433.

Fouladbash, L., Currie, W.S., 2014. Agroforestry in Liberia: household practices, perceptions and livelihood benefits. Agrofor. Syst. 89 (2), 247–266.

Fullerton, D., Mohr, R.D., 2003. Suggested Subsidies are Sub-optimal Unless Combined with an Output Tax Contributions to Economic Analysis and Policy Suggested Subsidies are Sub-optimal Unless Combined with an Output Tax. http://works.bepress.com/don_fullerton/29.

Gebreegziabher, Z., van Kooten, G.C., 2013. Does community and household tree-planting imply increased use of wood for fuel? Evidence from Ethiopia. Forest Policy Econ. 34, 30–40.

Göb, R., McCollin, C., Ramalhoto, M.F., 2007. Ordinal methodology in the analysis of Likert scales. Qual. Quant. 41 (5).

Goldstein, G., Hersen, M., 1984. Handbook of Psychological Assessment. Pergamon Press, New York.

Government of the Republic of Uganda (GoU), 2010. National Biomass Energy Demand Strategy 2001–2010.

Haile, K., Sandewall, M., Urgessa, K., 2009. Woodfuel demand and sustainability of supply in south-western Ethiopia, case of jimma Town. J. Forest. 3 (2) (ISSN1819-3439).

Hausman, J.A., McFadden, D., 1984. specification test for the multinomial logit model. Econometrica 52 (5), 1219–1240.

Hajjar, R., Kozak, R.A., 2015. Exploring public perceptions of forest adaptation strategies in Western Canada: implications for policy-makers. Forest Policy Econ. 61, 59–69.

Hassan, K., Halder, P., Pelkonen, P., Pappinen, A., 2013. Rural households' preferences and attitudes towards biomass fuels - results from a comprehensive field survey in Bangladesh. Energy Sust. Soc. 3 (24), 1–14.

Hung, S., Michael, W., 2005. Perception of economic distributive justice : exploring leading theories. Soc. Behav. Personal. Int. J. 33 (5), 435–454.

International Energy Agency (IEA), 2006. Energy for cooking in developing countries. In: Energy Balances of OECD Countries, 2006th ed. OECD/IEA, Paris, pp. 419–445.

Jiang, H., 2005. Grassland management and views of nature in China since 1949: regional policies and local changes in Uxin Ju. inner Mongolia Geoforum 36 (5), 641–653.

Joa, B., Schram, U., 2020. Conservation practiced by private forest owners in Southwest Germany – the role of values, perceptions and local forest knowledge. Forest Policy Econ. 115, 102141.

Kallio, M.H., Krisnawati, H., Rohadi, D., Kanninen, M., 2010. Mahogany and Kadam planting farmers in South Kalimantan: the link between Silvicultural activity and stand quality. Small-Scale Forest. 10 (1), 115–132.

Karanth, K.K., Nepal, S.K., 2012. Local residents perception of benefits and losses from protected areas in India and Nepal. Environ. Manag. 49 (2), 372–386.

Khan, S.R., Khan, S.R., 2009. Assessing poverty–deforestation links:evidence from swat, Pakistan. Ecol. Econ. 68 (10), 2475–2734.

Kindo, A.I., Mndolwa, M.A., Edward, E., Chamshama, S.A.O., 2010. Performance of four-year-old Australian and Papua New Guinean Acacia species/provenances at Kongowe, Kibaha,Tanzania. Southern Forests 2010 72 (1), 13–22.

Kulindwa, Y.J., 2016. Key factors that in fl uence households' tree-planting behaviour, 40 (2), 37–50.

Kumar, D.S., Barah, B.C., Ranganathan, C.R., Venkatram, R., 2011. An analysis of farmers ' perception and awareness towards crop insurance as a tool for risk Management in Tamil Nadu. Agric. Econ. Res. Rev. 24, 37–46.

Leung, S.F., Yu, S., 2000. Collinearity and two-step estimation of sample selection models: problems, origins and remedies. Comput. Econ. 15 (3), 173–199.

Malimbwi, R.E., Zahabu, E.M., 2008. Woodlands and the charcoal trade: the case of Dar es Salaam City, 98. Working Papers of the Finnish Forest Research Institute, pp. 93–114.

Martini, E., Roshetko, J.M., van Noordwijk, M., Rahmanulloh, A., Mulyoutami, E., Joshi, L., Budidarsono, S., 2011. Sugar palm (Arenga pinnata (Wurmb) Merr.) for livelihoods and biodiversity conservation in the orangutan habitat of Batang Toru, North Sumatra, Indonesia: mixed prospects for domestication. Agrofor. Syst. 86 (3), 401–417.

Matta, J.R., Alavalapati, J.R.R., 2006. Perceptions of collective action and its success in community based natural resource management: an empirical analysis. Forest Policy Econ. 9 (3), 274–284.

McCarthy, S., Matthews, A., Riordan, B., 2003. Economic Determinants of Private Afforestation in the Republic of Ireland, 20, pp. 51–59.

Mekonnen, A., Bluffstone, R., 2008. Is there a link between common property Forest management and private tree growing. In: Environment for development. Evidence of behavioural effects from highland Ethiopia. Discussion paper Series EfD DP 08.29.

Mekonnen, A., Damte, A., 2011. Private tree and household assets and determinant of tree-growing behaviour in rural Ethiopia. In: Washington, DC. and Gothenburg, Sweden: resources for the future and environmental for development. EfD Discussion paper series 11-14.

Miah, M.D., Koike, M., Shin, M.Y., Akther, S., 2011. Forest biomass and bioenergy production and the role of CDM in Bangladesh. New For. 42 (1), 63–84.

Mitchard, E.T.A., Flintrop, C.M., 2013. Woody encroachment and forest degradation in sub-Saharan Africa' s woodlands and savannas 1982–2006. In: The Royal Society under the terms of the Creative Commons Attribution Licens, 368, p. 0406.

Msuya, N., Masanja, E., Temu, A.K., 2011. Environmental burden of charcoal production and use in Dar es Salaam. Tanzania J. Environ. Protect. 2 (10), 1364–1369.

Mudaca, J.D., Tsuchiya, T., Yamada, M., Onwona-Agyeman, S., 2015. Household participation in payments for ecosystem services: a case study from Mozambique. Forest Policy Econ. 55, 21–27.

Mwampamba, T.H., Ghilardi, A., Sander, K., Chaix, K.J., 2013. Dispelling common misconceptions to improve attitudes and policy outlook on charcoal in developing countries. Energy Sust. Dev. 17 (2), 75–85.

Nguyen, T.T., Bauer, S., Uibrig, H., 2010. Land privatization and afforestation incentive of rural farms in the northern uplands of Vietnam. Forest Policy Econ. 12 (7), 518–526.

Norman, G., 2010. Likert scales, levels of measurement and the "laws" of statistics. Adv. Health Sci. Educ. 15 (5), 625–632.

Owuor, M.A., Icely, J., Newton, A., 2020. Community perceptions of the status and threats facing mangroves of Mida Creek, Kenya: implications for community-based management. Ocean Coast. Manag. 175, 172–179.

Paleti, R., 2015. Implicit choice set generation in discrete choice models: Application to household auto ownership decisions. Transportation Research. 80, 132–149.

Perdana, A., Roshetko, J.M., Kurniawan, I., 2012. Forces of competition: smallholding teak producers in Indonesia. Int. For. Rev. 14 (2), 238–248.

Prado, S.M.M., Sánchez, M.I.A., JAlejandro, J., 2019. Rosado anastacio academic literacy program implementation in an Ecuadorian University: a multinomial logit approach. Int. J. Adolesc. Youth 24 (3), 351–361.

Primmer, E., Paloniemi, R., Similä, J., Tainio, A., 2014. Forest owner perceptions of institutions and voluntary contracting for biodiversity conservation: not crowding out but staying out. Ecol. Econ. 103, 1–10.

Puhani, P.A., 2000. The Heckman correction for sample selection and its critique, 14 (1), 53–68.

Ramage, M.H., Burridge, H., Busse-Wicher, M., Fereday, G., Reynolds, T., Shah, D.U., Wu, G., Yu, L., Fleming, P., Densley-Tingley, D., Allwood, J., Dupree, P., Linden, P.F., Scherman, O., 2017. The wood from the trees: the use of timber in construction. Renew. Sust. Energ. Rev. 68, 333–359.

Robinson, E.J.Z., Lokina, R.B., 2012. Efficiency, enforcement and revenue tradeoffs in participatory forest management: an example from Tanzania. Environ. Dev. Econ. 7 (01), 1–20. Cambridge University Press.

Roshetko, J.M., Snelder, D.J., Lasco, R.D., van Noordwijk, M., 2008. Future challenge: A paradigm shift in the forestry sector. In: Snelder, D.J., Lasco, R. (Eds.), Smallholder Tree Growing for Rural Development and Environmental Services. Springer Science & Business Media, pp. 453–485.

Ruseva, T.B., Evans, T.P., Fischer, B.C., 2015. Can incentives make a difference? Assessing the effects of policy tools for encouraging tree-planting on private lands. J. Environ. Manag. 155, 162–170.
Sabastian, G., Kanowski, P., Race, D., Williams, E., Roshetko, J.M., 2014. Household and farm attributes affecting adoption of smallholder timber management practices by tree growers in Gunungkidul region, Indonesia. Agrofor. Syst. 88 (2), 258–268.
Schildkraut, J., Nickerson, A.B., Ristoff, T., 2019. Locks, lights, out of sight: assessing Students' perceptions of emergency preparedness across multiple lockdown drills. J. Sch. Violence 19 (1), 93–106.
Stoneham, T., 2002. Berkeley's World. An Examination of the Three Dialogues. Oxford University press, Oxford.
Strazzera, E., Scarpa, R., Calia, P., Garrod, D.G., Willis, G.K., 2003. Modeling zero values and protest responses in contingent valuation surveys. Appl. Econ. 35, 133–138.
Tesfaye, Y., Roos, A., Bohlin, F., 2011. Attitudes of local people towards collective action for forest management: the case of participatory forest management in Dodola area in the Bale Mountains, Southern Ethiopia. Biodivers. Conserv. 21 (1), 245–265.
Tessema, Y.A., Aweke, C.S., Endris, G.S., 2013. Understanding the process of adaptation to climate change by small-holder farmers: the case of east Hararghe zone, Ethiopia. Agricult. Food Econ. 1, 13.
Trac, C.J., Harrell, S., Hinckley, T.M., Henck, A.C., 2007. Reforestation programs in Southwest China: reported success, observed failure, and the reasons why. J. Mt. Sci. 4 (4), 275–292.
Turinawe, A., Drake, L., Mugisha, J., 2015. Adoption intensity of soil and water conservation technologies: a case of South Western Uganda. Environ. Dev. Sustain. 17 (4), 711–730.
URT, 2002. The Forest ACT, 2002. Arrangement Of Sections. *https://www.tnrf.org/files/E-URT_LAWS_Forest_Act_2002_0.pdf*.
URT, 2007. Ministry of Natural Resources and Tourism. Guidelines for Sustainable Harvesting and Trade in Forest Produce.
URT, 2012. National Strategy for Reduced Emissions from Deforestation and Forest Degradation (REDD+). The Vice President's Office, Dar Es Salaam, Tanzania.
URT, 2014. Basic Demographic and Socio-Economic Profile Report Tanzania. National Bureau of Statistics Ministry of Finance, Dar es Salaam.
USAID, 2009. World Population Data Sheet. NW, Washington, DC USA. www.prb.org.
Vossler, B.C.A., Doyon, M., Rondeau, D., 2012. Truth in consequentiality: theory and field evidence on discrete choice experiments, 4 (4), 145–171.
Wolfold, S.E., Siegel, J., 2018. Misaccounting for endogeneity: the peril of relying on the heckman two-step method without a valid instrument. Strateg. Manag. J. 40 (3), 432–462.
Wooldridge, J.M., 2010. Econometric Analysis of Cross Section and Panel Data, 2nd edition. MIT press.
World Bank, 2009. Environmental Crisis or Sustainable Development Opportunity? Transforming the Charcoal Sector in Tanzania. A Policy Note, Washington DC.
World Bank, 2013. Tanzania National Panel Survey, FAO Statistics. Data from these surveys are publicly available and results can be readily replicated. http://blogs.worldbank.org/africacan.
Yin, R., Yin, G., 2010. China's primary programs of terrestrial ecosystem restoration: initiation, implementation, and challenges. Environ. Manag. 45 (3), 429–441.
Zhao, J., Kim, H.J., Kim, H.M., 2020. New EM-type algorithms for the Heckman selection model. Comp. Stat. Data Anal. 146, 106930.
Zubair, M., Garforth, C., 2006. Farm level tree-planting in Pakistan: the role of farmers' perceptions and attitudes. Agrofor. Syst. 66 (3), 217–229.