Worku *et al. Environ Syst Res (2017) 6:10*
DOI 10.1186/s40068-017-0087-4

Environmental Systems Research

RESEARCH

Household level tree planting and its implication for environmental conservation in the Beressa Watershed of Ethiopia

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Abstract

Background: Elsewhere in other developing countries, and 85% of the Ethiopian population is living in rural part of the country and more than 90% of domestic energy source is dependent of traditional biofuel. Increase in population is causing more demand for human use and more pressure on natural resources. This adversely affect the increase of multi-purpose and indigenous tree plantation and ago-forestry practice and hence has a vicious circle with food security. However, following the start of community based watershed management practice, households are encouraged to plant trees on their private land, which contributed to the increase of forest coverage. Therefore, the objective of this study was to assess household level tree planting, domestic energy consumption, and explore implication for environmental conservation.

Results: Fuelwood and dung was major source of domestic energy in the area, consumed on an average 2280 and 1533 kg/year respectively and the total biofuel consumption was 268.06 t/year. The decline in natural forest and increase in demand for wood motivated people to have privately planted trees. Though it was variable among various socio-economic characteristics of farmers, tree planting was encouraged, based on ground reality. Therefore, promoting private based tree plantation should be considered as economic relief and filling the demand gap of fuelwood. Likewise, the opportunity cost of dung available for soil conditioner. The use of fuel saving stove and other alternative source of energy should be encouraged.

Conclusion: Local context policy option used for favoring for the allocation of bare land and mountainous topography for community and private tree planting for landless and small holder farmers has to be encouraged.

Keywords: Fuelwood, Dung, Deforestation, Soil erosion, Land degradation, Agro-forestry, Environmental conservation

Background

Conversion of forest for human use is one of the most serious challenges of the planet, resulted alarming increase in climate change and environmental degradation. Rural dwellers depending on subsistence agriculture are highly susceptible to natural resource degradation and climate change (Slingo et al. 2005; Meijer et al. 2015). In developing countries, forest resources and various biodiversity are declining. To a large extent, this has resulted from increasing human population, as intensive agriculture pressure increases on natural resources (FAO 2007; Ndayambaje et al. 2012; Meijer et al. 2015). Between 2000 and 2005 in developing countries, especially in Africa more than 4 Mha of natural forest was lost annually (FAO 2007; Ndayambaje et al. 2012). Forest degradation in turn resulted for scarcity of fuelwood and other substantial antagonistic consequences, such as watershed functions deterioration, loss of biodiversity, carbon dioxide release into the environment and intensive soil erosion (Jain and Singh1999; Heltberg et al. 2000; Pandey 2002).

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According to United Nations Economic Commission for Africa (UNECA 2004; Bewket 2005 and Gebreegziabher et al. 2010), economic growth, self-sufficiency and alleviating poverty is limited in developing countries especially in sub-Saharan Africa due to in insufficient provision of energy service. A majority of the population depends on firewood and livestock dung as a source of energy, and thus accelerating the problems of environment and land resource degradation (Meshesha et al. 2016). Fuelwood gathered from the forest is a common phenomenon and important source of domestic energy in rural area of the globe. More than half of the world's population cook with traditional biofuel source, which provides around 35% of domestic energy supplies in the developing countries (Heltberg et al. 2000). On the basis of Pandey assessment in 2002, in most rural part of India the dominant source of household domestic energy is remained on fuelwood, crop residue and dung cake. However, the share of consumption is varies considerably, and largely depending upon the availability, the cost in terms of required time for collection.

Like other developing countries, in both urban and rural parts of Ethiopia, traditional biofuel is a source of energy (Miller 1986; Bewket 2005; Abreham and Belay 2015). For instance, in urban areas the largest share of domestic energy is from fuelwood (55.4%), the remaining 44.6% of energy is covered from charcoal, cattle dung, and agricultural crop residue which comprises 9.3, 8.4 and 6.8% respectively. The share of modern sources of household energy consumption includes 15.35% of kerosene, 0.28% of diesel and 4.75% electricity which account 20.38% of the total domestic energy consumption. On the other hand, in rural area in which majority of the population living more than 99% of domestic energy source is dependent on traditional biofuel. Fuelwood holds more than 80% followed by cattle dung and agricultural residue (9.25 and 8.31% respectively) (Bewket 2005). According to EREDPC/MoRD (2002), fuelwood with charcoal, animal dung with crop residues comprises 83 and 16% respectively, on the other hand electricity and petrol accounts for 1% to satisfy the total household domestic energy consumption. In general, 99.9% of the total domestic energy consumption of rural households is originated from biomass fuels.

Like agricultural land expansion, the growing demand for fuelwood is a serious cause of the high rate of deforestation in Ethiopia (Worku and Tripathi 2016). Increasing in the traditional fuelwood consumption level of the community and coupled with insufficient utilization of the available resource have led to more tension on natural resource (Arrow et al. 2004; Godfray et al. 2010; Lin et al. 2011; Mislimshoeva et al. 2014).

The share of natural forest coverage in Ethiopia has been decreasing at an alarming rate, from 40% of land area around 50 Mha just before the turn of the last century to 3.6% by the early 1980s (Cheng et al. 1998) and the clearance of resource was continuous, and by the early 1990s much of the cover was destroyed and only 2.3 Mha of land forest cover remained (EFAP 1993; Bewket 2005).

According to WRI (1990), the rate of reforestation was only 13,000 ha/year; on the contrary the rate of deforestation was 88,000 ha/year. Similarly, one report indicated that the rate of deforestation was 150,000–200,000 ha/year. Davidson (1988) and Wood (1990) predicted that if deforestation is continuing at the rate of 100,000 ha/year, all the highlands parts of Ethiopia will be cleared by the year 2020.

The rapid loss of forest land has raised the concern of local, national, and international communities. Many local communities now work harder to collect firewood and construction materials. In some villages women spend 6 h, walking 10 km each way, to collect wood (Cheng et al. 1998). Similarly, Heltberg et al. (2000), to collect fuelwood from forest in India during winter season women make 1–8 journeys per a week, which headed-loaded back to their house and it took from 1.5 to 6 h. In general, each household especially in rural part of the country in which domestic energy is relied on traditional fuel source spend over the year ranges between 34 and 504 h with a mean of 190 h.

It is obviously a result of deforestation and de-vegetation. Fuel-wood shortage has serious consequences as households are forced to replace wood by using agricultural crop residue and livestock dung. This is instead of use to increase soil fertility, and will significantly affect agricultural crop production.

According to Heltberg et al. (2000), in many parts of Asia and Africa animal dung is used for household energy consumption. But dung is used as source of manure, and using it for fuel can have substantial negative effect on soil fertility. More than 97% of overall food for population of the world originated from natural resource. However, land degradation and soil erosion are a striking problem at the global level (Munro et al. 2008; Mekuria et al. 2009). In 1980s, 1–1.5 million tons of agricultural crop was lost per year through use of livestock dung and agricultural crop residue as fuel source instead of using it for soil amendment. Likewise, the adverse effect is challenge the availability of productivity in Ethiopia. In appropriate natural resource use practice, and compatibility of policy based on the local socio-economic context of the community have been the pressing cause of resource degradation (Munro et al. 2008; Mekuria et al. 2009). Serious land degradation has resulted in a reduction of crop productivity, leading to demand for additional food aid (Newcombe 1987; Alemu 1999). Similarly, Araya and Edwards (2006) estimated that 600,000 tons of agricultural crop production has been lost per year as a result of livestock dung rather than use for maintaining soil fertility.

Following increase in population, there has been more demand for domestic energy and hence increased in devegetation and depletion of soil. Taking this catastrophe into consideration development of energy supply for both rural and urban area of the country should give priority. Even though different literatures has identified a high rate of deforestation in the country (Davidson 1988; Aklog 1990; WRI 1990; EFAP 1993), only limited studies have explored the impact of household level tree planting on soil properties (Meaza and Gebresamuel 2013), rural household fuel production and consumption (Alemu 1999), energy, growth and environmental interactions (Gebreegziabher et al. 2010). A few studies have explored household level tree planting and its impact on environmental conservation. Therefore, the objective of this paper was to assess household level tree planting, energy consumption pattern, source, and its implication on environmental conservation.

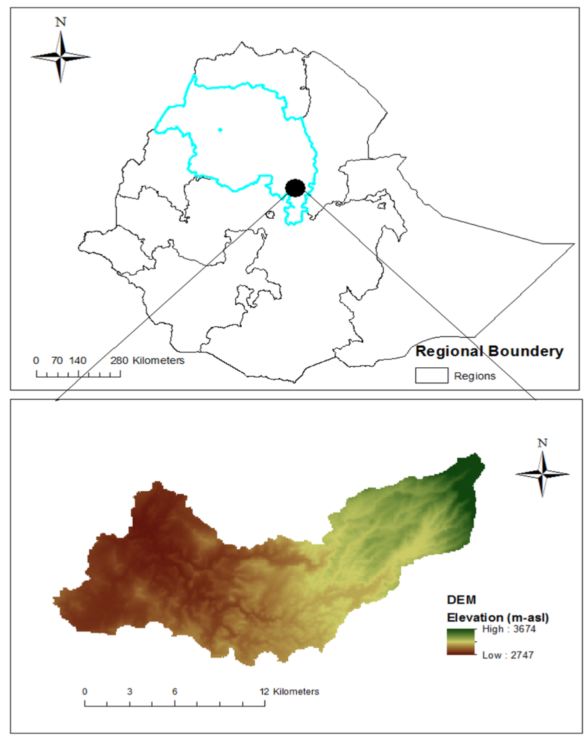

Fig. 1 Location study area

Research site

The study watershed lies within 39°37′E and 9°41′N. In administrative terms, it is located Basona Woreda (District), North Showa zone of Amhara regional state. Situated north east of capital city, Addis Ababa, the watershed forms parts of central highlands of Ethiopia which is the parts of Abay basin (Fig. 1).

The watershed is characterized by diverse topographic conditions like mountainous and dissected terrain with steep slopes. The elevation ranges from 2747 to 3674 m a.s.l. The annual average temperature of the area is 19.7 °C; annual maximum rainfall is 1083.3 mm, with a minimum amount recorded 698.5 mm. The most common types of soil are Cambisols (locally called *Abolse*), vertisols (*Merere*), Andosols, Fluvisols and Regosols. Mixed crop- livestock is farming system of the study area. Barley, wheat, horse beans, field peas, lentils and chick peas are the most commonly growing crops in the area. Cattle and sheep are the dominant types of livestock, but goats, horses, and chickens are also common. The farming system is depending on rain-fed system and farmers are always worried about the duration and intensity of rainfall.

Data and methods

According to Biratu and Asmamaw (2016), Elsewhere in Ethiopia from the total 2020 household heads, 5% (101) samples were selected using stratified sampling techniques. Likewise, Moges and Holden (2007), in South part of Ethiopia 5% of farm household from the total household heads were taken for survey study using simple random sampling techniques. Bewket (2005), in order to undertake survey study in the Northern highlands of Ethiopia, with 3670 total households based on systematic random sampling system 133 (~4%) samples size were taken. Gebre et al. (2013), elsewhere, in Ethiopia like our sample size from nearly similar total household size 92 samples were taken using random sampling procedure for the interview. According to Ayele (2009), proportionate sampling techniques was employed in order to undertake his study therefore from 10,094 total populations he used to select 150 samples households.

Therefore, the data for this study obtained from structured household survey conducted from May to August 2015. The procedure was as follows, 92 sample household were selected randomly while different soil and water conservation work was implemented. Initially structured questionnaire was prepared and pre-tested for quantitative information. The interview was done by going to the watershed member's homestead and during community watershed management practice. Additional information was obtained through focused group discussion, key informant interview, field observation and informal discussion while community watershed management practices.

The most important and dominant source of biofuel in the study area is fuelwood and cattle dung. Therefore, in the survey questions included about the quantity of biofuel used, source of biofuel, level of tree planting, distance traveled to collect biofuel, and farmer's response on shortage of biofuel. It is difficult to ask the weight of fuelwood and dug consumed, but, in the interviews it was asked to mention the number of bundles of wood and basket of dung consumed per a week. The size of bundles of wood varies depending upon the person carrying it and the size of basket of dung varies depending upon the size and patterns of stacking the dung cakes. The researchers tried to determine the mean weight of dry wood and cattle dung. According to Bewket (2005) and as per present study, the average weight of a bundle of wood and a basket of dry dung was 12.5 and 6 kg respectively. The survey also included socio-economic data about household size, size of land holding, income earned from crop production, off-farm income, cattle ownership, sale of wood and trees. After having all the pertinent information, correlation matrix, descriptive and least significance difference (LSD) test has employed using SPSS software version 23.

In addition to the above statistic, econometrics model (Probit models) has applied in this study to identify household's decision to plant tree, number of trees planted, and biofuel consumption. In the model, household who do not have access to plant trees has considered. The use of probit model is useful to distinguish the determinant of household level decision to plant trees, number of tree planted and the domestic energy consumption in their home. The model described in the following ways:

$$y_i^* = x_i'\beta + \varepsilon_i, \sim NID\,(0,1) \tag{1}$$

where, y_i^* is unobserved and is referred to as a latent variable.

Therefore, the individual i chooses to participate in planting trees at the household and community level when the variation of planting and not plant tree surpasses a certain threshold, null in this case, thus, $y_i = 1$, if and only if $y_i^* > 0$; and $y_i = 0$, if $y_i^* \leq 0$. Therefore, the latent variables are depends on the value of x:

$$\begin{aligned} \Pr\left(y_i = \frac{1}{x_i}\right) &= \Pr\left(y_i^* > 0\right) = \Pr\left(u_i \geq x_i'\beta\right) \\ &= 1 - F\left(-x'\beta\right) = F(x'\beta) \end{aligned} \tag{2}$$

where, $F(x_i'\beta)$ is a cumulative distribution function, which is associated with the expected distribution of error term.

According to Wooldridge (2002), maximum likelihood has used to estimate the value of β. However, the degree of β value is not particularly meaningful except in the special case. So, both in the continuous as well as discrete explanatory variables, it is significant to know how to interpret the value of β. When the value of β is estimated, the effect of marginal change in the *i*th variables in X, X_j, is described in the form of:

$$\frac{\partial \Pr(Y_i = 1)}{\partial X_{ij}} = f'(X_i'\beta)\beta_j \tag{3}$$

The value of marginal effects therefore, is depend on the value of X_i we used. Hence, the mean value of X_i in the observed sample are used to obtain the value of *f* (βX_i). Finally, the effect of X_j variables on the willingness of the community and household planting trees at the household and community level specified by the magnitude and signs of the marginal effects.

Results and discussion

Biofuel consumption in the study watershed

Fuelwood consumption

Elsewhere in rural part of Ethiopia, in the study area fuelwood is the main source of energy. The entire household fuelwood consumption was ranged from 304 to 4258 kg/year. The majority of households (15.2 and 14.1% from the total population) biofuel consumption comprised of 1825 and 2433 kg/year respectively (Table 1). The average household fuelwood consumption was 2280 kg/year. The total fuelwood consumption in the watershed was 172,868 kg/year, which is equivalent to (~172.868 tonnes/year) with mean quantities of 1902.95 kg/year (Table 1). In line with Guta (2012), study the total annual fuelwood and animal dung consumption elsewhere in rural part of Ethiopia estimated to be 2154 and 1825 kg respectively. Similarly, to the study by Mekonnen and Kohlin (2009), the total quantity of fuelwood consumed fluctuated between 2004 and 2143 kg/year in 2005, it was nearly the same with findings of the present study, which indicated that the consumption of fuelwood as a source of domestic energy is increasing over time and negatively related with environment. The annual fuelwood consumption of

Table 1 Annual domestic biofuel consumption in Beressa Watershed

Consumption of fuel wood		Consumption dung cake	
kg/year	% Population	kg/year	% Population
≤800	9.8	≤450	23.9
800–1600	32.6	450–900	33.7
1600–2400	19.6	900–1350	16.1
2400–3200	28.3	1350–1800	7.6
≥3200	8.7	1800–2250	4.4
		≥2250	13

household was significantly varied among each other, as indicated by least significance difference (LSD) result ($f = 2.80$, $p = 0.0001$) and the variation of fuelwood consumption over time in the study area resulted from absence of fuel saving stove (65.2%), other things citreous paribus[1] such as household size, income level, cattle population and number of tree planting. According to Nanda and Khurana (1995) and Saxena (1997) besides increasing in consumption, the use of traditional biofuel expose user causes to health problems such as eye and lung diseases due to kitchen smoke, especially for females, who devote long hours in close proximity to kitchen. Majority of households was using traditional three stone stoves. Only 34.8% of the respondents were using fuel saving stove locally called "Gonze".[2] Obviously rural people are fulfilling their demand of fuelwood anywhere from agricultural land, natural forest, and grazing land and fallow land (Jaiswal and Bhattacharya 2013). Even though people in all over rural parts of the country in general, the study area in particular depend on natural forest, privately planted trees and community plantation used for fuel source and construction at large, and less community plantation and natural forest comprised of 7.6 and 5.4% respectively.

In addition to acceleration of land degradation and loss of agricultural productivity because of clearing of natural forest, degradation contributes negatively for further shortage of fuel-wood. It is observed that due to deforestation of natural forest households were spending considerably more time in collecting fuelwood over long distances. As a result, households were substituting dung cake for fuel consumption, which has important implications for agricultural production. Therefore, participants were roughly asked to assess average time travelling to collect biofuel before and after community based watershed management practice. The estimate of average time may not accurate so care has to taken during assessment (Fig. 2). The average return time before the project was 121 min. By assuming the average walking of person is 5 km/h, distance traveled for fuelwood collection therefore was 10.08 km. Recently equivalent distances take 92.3 min, which is equivalent to 7.66 km distance for fuelwood. As a result of increasing community plantation around homestead and farm area they were turned their face to private tree plantation for domestic utilization (97.8%) and in turn reduced distance traveled for fuelwood from 10.08 to 7.66 km.

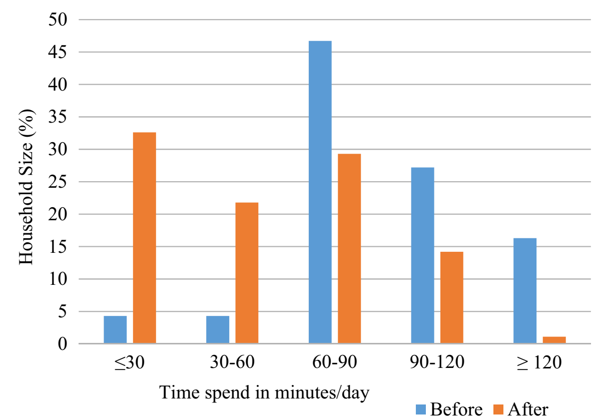

Fig. 2 Comparison of time spending for fuelwood collection before and after watershed management

Dung fuel consumption

Similarly, cattle dung cake holds the most important source of household's energy consumption next to fuelwood. The annual dung consumption of the study watershed ranged from 146–2920 kg/year, with total quantity of 95,192 kg/year–95.192 t/year (already presented in Table 1). Majority of households used 876 kg/year, which is lower than the average (1533 kg/year) and the mean quantities was 1050.46 kg/year. In contrast, the other studies concluded that the total average quantity of animal dung cake used as fuel source reduced from 1307 to 1157 kg/year in 2000 and 2005 respectively (Mekonnen and Köhlin 2009).

Clearing of forest and degradation of land are interrelated with use of fuelwood and cow dung as domestic energy source, which are the most serious environmental problems for the country. For instance, using dung cake for energy source negatively contributed for the availability of manure for soil conditioner to boost agricultural productivity (Mekonnen and Köhlin 2009). One of the most serious constraints of food security was soil fertility depletion. Manure is an important soil conditioner used to enhance fertility of the soil (Raj et al. 2014). As Fulhage [(2000), cited in Raj et al. (2014)] manure contains N, P, K, Mg, Ca, S, Zn, Cu, B, Mn etc. (Table 2). These are used to improve soil tilth, water holding capacity of the soil and aeration, in turn used to increase agricultural productivity. Therefore, use of dung as source of domestic energy reduces the opportunity cost of using it as soil fertility amendment, as cattle dung contains very important nutrients which are suitable for soil fertility.

To fill the gap of domestic energy source 95.192 tonnes of cattle dung burnt annually and loss many more macro and micro nutrient which is suitable for soil fertility improvement. Instead of using as a soil fertility

[1] Citreous paribus is an economic term refers to other thing remain constant.

[2] Backing and cooking fuel saving stove technology produced from cement and sand mostly used by rural population.

Table 2 Estimated nutrient loss from burning of cattle dung [source: Lupwayi et al. (2000)]

Source	Nutrient [(kg/tonne year) on dry biomass bases]								
	N	P	K	Ca	Mg	Fe	Mn	Cu	Zn
Cattle dung	18.3	4.5	21.3	16.4	5.6	10.78	0.78	0.02	0.09

amendment, burning cattle dung for domestic energy source-therefore has negative implication for agricultural productivity especially for developing country like Ethiopia-importing fertilizer from abroad.

Dung was collected from different places of the study area from private grazing land, communal grazing land, and prepared from privately own cattle in their home. Elsewhere in rural parts of Ethiopia, in the study watershed in addition to performing household chores and raising children the responsibility of collecting fuelwood mostly handed by females and children too. However, every family member performed the activity.

Biofuel consumption pattern and socio-economic characteristics

The annual biofuel consumption of the study watershed ranged from 450 to 7118 kg with the average consumption of 3813 kg/annum. The variation of biofuel consumption is susceptible to various factors. The requirement of fuelwood is subject to population size, availability of biofuel nearby their home, number of cattle population they have. However, increase in population number makes availability of fuelwood lagging behind the need for domestic use (Swaminathan and Varadharaj 2001).

The use of biofuel consumption in the study area was variable, the variation reflects there were different factors that influence the total quantity of biofuel consumed in a year. There was positive correlation between fuelwood consumption and household size, which was statistically significant ($r = 0.472$, $p < 0.01$) (Table 3), this indicates larger households need additional fuelwood to prepare household food. Similarly, the size of households and use of dung cake were significantly correlated ($r = 0.401$, $p = <0.01$), possibly because larger family needs more energy consumption and they have possibly free labor to collect dung. The association between size of land holding and biofuel is statistically insignificant ($r = -0.54$, $p > 0.05$), which indicates large land holders do not have better option of getting more biofuel. The association between number of tree planted and fuelwood was statistically insignificant. Likewise, no significant association between dung consumption and number of tree planted. Instead of using wood and trees for domestic energy source households used to prefer to earn additional income for selling to nearby market rather than replacing dung cake as a fuel source. Therefore, the availability of different micro and macro nutrient obtaining from dung to the soil became scarcer and scarcer-in turn positively contributed for food insecurity.

In the present study it has been found that cattle ownership was positively correlated with dung cake. Households that owned large number of cattle have additional opportunity for preparing dung cake in their home. On the contrary it is found that the association between cattle ownership and fuelwood was negatively correlated. Therefore, more cattle they have, more tendency of using dung for domestic use. In turn positively contribute for having more trees and wood free for home construction and earning additional cash income.

There was a significant positive correlation between income level of households and fuelwood, ($r = 0.048$, $p < 0.05$). On the other hand, income and dung was not statistically significantly correlated. The possible explanation may be more income from sale of farm produce and off-farm income earned, fuel saving stove used and therefore, using dung as soil fertility amendment hence boosting agricultural production and productivity.

Table 3 Correlation matrix indicates biofuel consumption and influencing factors

Characteristic	Fuelwood	*p* value	Dung cake	*p* value
Size of households	0.472**	000	0.401**	000
Size of land holding	−0.54	0.613	−0.30	0.779
Number of trees planted	−0.28	0.796	−0.180	0.089
Livestock ownership (cow and oxen)	−0.203	0.055	0.166	0.117
Income earned (farm produce and off-farm income)	0.209*	0.048	0.195	0.065

* Significant at 0.05 level

** Significant at 0.01 level

Household level tree plantation to the livelihoods strategies

The number of tree planted per a year was variable among different households-ranged from 0 to more than 520. Tree planted around farm plot and homestead therefore positively contributed in last decade for the increase of forest coverage. The total number of trees planted per a year was 11,330 with the average of 243 trees per households (Fig. 3). In line with this, a study by Bewket (2005), in the north-western highlands of Ethiopia of Chemoga watershed inferred in the last four decades farm and community level tree planting has substantially contributed for the increase of forest cover, even though there is difference between planted trees and natural forest cover with averagely 307 trees planting per household. According to Ndayambaje et al. (2012), in Rural Rwanda out 480 of the total households, 350 of them were planting 1–4 trees species in their farm plots. Similar findings, Sandewall et al. (2015), average planted tree area conserved and managed by households accounted by about 0.4 ha/hh in China, 0.3 ha/hh in Ethiopia and 0.4 ha/hh in Vietnam. Being, stipulated by market and government favorable policies for climate resilient green economy together with erratic rainfall, households was increasingly decided to tree planting operation in their homestead and around farm plots. Through planting trees and earning cash income for their survival, simultaneously reduced dependence on crops. Similar finding by Sandewall et al. (2015), planted trees and natural forest are the second income source as a percent of total households in Ethiopia after crop production and 6–25% for Vietnam. However, increase of tree and forest plantation at the expense of unsustainable farm rises incomes for some, it did not immediately bring household out of food insecurity and shortage.

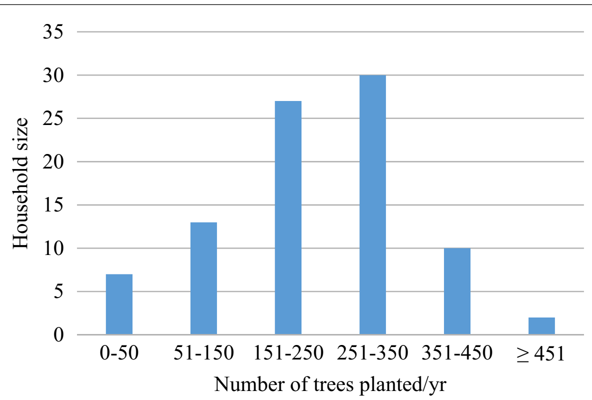

Fig. 3 Number of trees planted

Other reason farmers decided to plant tree compared to producing crops because growing of trees required less labors. *Eucalyptus* tree was the most dominant types of tree planted in the watershed (more than 90%) which is followed by *Juniperus procera* tree (locally called *Tid*) to some extent *Sesbania sesban*, *tree Lucerne, shrubs* and *grass* was recently practiced. Due to fast growing, less time required for treating and less susceptible to climate change farmers preferred *eucalyptus* tree. On the contrary, from long experience they had farmers expressed *eucalyptus* tree has negative ecological effect, as it needs large volume of water requirement. Many controversial points listed in various studies about the benefit and ecological effect of *eucalyptus* tree. According to Zhang (2012), for instance various biological debris and soil fertility was reduced because of rehabilitation of *eucalyptus* tree. Simultaneously the growth rate of *eucalyptus* tree faster than any other forest and tree species and needs large amount of water—cause for degradation in biodiversity. Similar findings by (Bone et al. 1997; Lemenih 2004), *Eucalyptus* tree has negatively affect the ecosystem services by for instance reducing soil moisture content and reducing the groundwater. Contrary to this, being planted *eucalyptus* tree precipitation has increased by 152.5 mm/annum, 75.3 mm reduction in evaporation annually.

Regardless of negative ecological as well as environmental effects, which needs further deep study on clear advantage and disadvantages, *eucalyptus* tree was a means of economic relief for households especially during drought period through earning additional cash income (Jagger and Pender 2003). From the survey, we concluded that more than 85% of households were sold trees to nearby market to earn additional cash income. Similar study by Holden et al. (2003), *Eucalyptus* tree plantation on marginal and degraded lands has positive effects on crop production and land conservation.

To meet the demand especially for home construction household were used their privately planted tree near homestead as well as farm plots (90%). This study inferred that, unlike many other studies on natural forest of the country that simply farm households believed to be the agent for deforestation, we observed that rural households were also be the actor for increasing the coverage of forest. Similarly, study by (Kajembe 1994; Price and Campbell 1997), elsewhere in many developing countries of the world confirmed that rural households play significant roles in the indigenous tree planting and management of their forest resources.

The analysis of association between tree planting and various household socio-economic characteristics showed that there was positive correlation between age of households and number of tree planted, which was statistically significant ($r = 0.245$, $p < 0.01$). Household size was positively correlated with tree planting, which indicated that the higher the size of household, the more free labors were available for planting trees. The association between education background of household and planting trees was significantly correlated ($r = 0.049$, $p < 0.05$). On the basis of statistical analysis farmers who were able to read and write have better information about the benefit of planting trees than who have not. Household income was not significantly related to planting trees ($r = -0.123$, $p = 0.07$). Likewise, the association between the size of land holding and number of tree planting was not significant. This is because planting trees operated around homesteads. In addition, youngsters who have less farm plots eager to have additional cash income-devote to have more trees.

Based on probit model result indicated that having land use right certificate significantly increase level of tree planting. In line with this, the anticipation of land use certificate is likely householder more self-assured in order to decide growing trees in their own land (Table 4). Similarly, previous study by Holden et al. (2009), confirmed that land use certification is likely affect household decision on planting trees.

The result for household-level variables confirmed that household's, education, age, gender, family size, and biofuel consumption per household were significant variables, which inferred more likely to plant trees. On the other hand, credit accesses, off farm income, size of land holding and number of livestock tending are less likely to influence the household decide to plant trees.

Conclusion

Elsewhere in developing country, for Ethiopia in general, in the study watershed people relied on traditional biofuel. There has been conflict between natural resource and people dependent on subsistence farming and still unresolved issue in the problems of biodiversity.

Alarming growth rate of population and hence accelerating in rate of deforestation of natural forest and the growing demand of household domestic energy source, household level tree planting used to reverse the scarcity. Likewise, it has positive impact on economic relief and to the environment as well. Due to the growing demand of energy for domestic use, household turned to using dung for energy source. Hence, the use of cattle dung for soil fertility improvement was limited. A possible solution to reverse the problem is encouragement of households to use more efficient fuel saving stove. So that the use of cattle dung as organic fertilizer can be increased and hence agricultural diversification. Besides using of cattle dung for soil fertility improvement and agricultural productivity, it used to reduce foreign currency spending on importing chemical fertilizer from abroad. Therefore, homestead and bare land private and community tree plantation should be encouraged as strategy to reduce further pressure on natural forest and ecological and environmental conservation.

Eucalyptus and *Juniperus* tree (locally known as *Tid*) are the dominant tree types in the study area, the interviewed households stated that they were unable to get fodder to feed their livestock. To reduce shortage of fodder problems, soil erosion and land degradation, to meet fuelwood requirement, promotion and encouragement of planting multi-purpose and indigenous tree should have done. On the basis of ecological and economic analysis, private and community level tree planting, and localized natural resource management should be implemented. Therefore, allocation of bare land, hillside and degraded land for private tree planting at large create more responsibility for local households.

Finally, it can be concluded that households level multipurpose tree plantation and agro-forestry practice based on local context should be acknowledged. Because, it has immense positive contribution for increasing natural forest coverage, ecological succession, reducing natural resource degradation, increase the availability of fuelwood and earning cash income and then reduce pressure of using dung for domestic fuel source. Therefore, it has inclusive benefit not only for land owner but also have not because they will have a chance getting benefit from the rehabilitated watershed.

Table 4 Probit model result for household level of tree planting

Variable	Probit model result	Variable	Probit model result
Family size	−0.015*	Size of land holding hectares	0.23**
Education level	0.012*	Land use certificate (right)	0.781*
Age of household head	−0.003*	Off farm income	0.123**
Gender of household	0.003*	Biofuel consumption per household	0.001*
Livestock number	0.062**	Credit accesses	0.204**

* Significant @ 5%

** Not significant

Authors' contributions

In the acquisition of the data, data collection, data coding and entry, data analysis, interpretation of the result, and writing has been substantially contributed by TW, SKT and DK have been involved in critically advising, revising the manuscript and made possible suggestion. All authors read and approved the final manuscript.

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Acknowledgements

This research was supported by the Ministry of education, government of Ethiopia. Prof. S.K Tripathi and Prof. Deepak Khare, Department of Water Resource Development and Management, India Institute of Technology Roorkee are acknowledged for the valuable comment on the manuscript. Sincere thanks also extended to all who took part for the manuscript. For the insightful comments special thank extended for editors and anonymous reviewers.

Competing interests

The authors declare that they have no competing interests.

Received: 22 May 2016 Accepted: 6 February 2017
Published online: 14 February 2017

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