The Importance of Farm Trees in Rural Livelihoods in Eastern Galabat Locality, Sudan

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ABSTRACT

The objectives of this study were to: (i) assess the share of farm trees in farmers' total income; (ii) determine and analyze the factors influence the farmers' decision on farm trees planting; and (iii) identify the attitudes and perceptions of farmers towards planting farm trees. A sample of 60 farmers was purposively selected from Galabat locality in 2015 and interviewed using a structured questionnaire. The data were analyzed using descriptive statistics and linear regression analysis. Farm tree products were found contribute 31% of farmer’s total annual income. Farmer’s land holding in feddan ($P=0.009$), farmer's family size ($P=0.000$), farmer’s income ($P=0.042$) and extension services from Forests National Corporation (EXT from FNC) ($P=0.001$) were found to positively and significantly associated with farmers’ decisions to plant trees on farmlands. The study results also indicate that the farmers have awareness of the benefits associated with trees, and their attitudes towards trees planting are mostly positive. It is concluded that farmer’s decisions to plant farm trees are driven by their socioeconomic circumstances. Thus, it is recommended that the farmers' socioeconomic characteristics should not be overlooked when designing future tree planting programs in the region.

1. Introduction

Sudan covers an area of 1.9 million km² with a total population of more than 36 million, with rapid growth rate of 2.3% per annum. Most of the population (70.5%) live in rural areas and many are considered forest dependent (e.g. Glover and Elsiddig, 2012). However, the forest resource is threatened by deforestation, driven predominantly by energy needs and clearing for agriculture (Badri, 2012). According to FAO (2013), the ongoing process of land degradation is a critical issue that affects the livelihoods of large sector of the rural population. Removal of tree cover for crop production, felling trees for fuelwood and building poles, in addition to overgrazing, are factors that together with drought conditions resulted in desertification and consequently shortage in food crops, as well as loss of soil fertility (El-Tahir et al., 2009). Another cause of land degradation in Sudan is the clearing of rangelands for mechanized rain-fed agriculture and shifting cultivation (FAO, 2008). According to Glover and Elsiddig (2012) and Biro et al. (2013), many areas in central and eastern Sudan covered by natural forests have been converted to mechanized rain-fed agricultural schemes for cultivating cash and subsistence crops.

To safeguard against the problems of deforestation and land degradation, the Sudanese government introduced the Investment Act of 1990 and the Ministerial Order 345/95 which obliged all land proprietors to conform to the allocation of 10% of their farmland for forestry (shelterbelts or forest cover), and to allow 20% of the holdings for forestry (that is by not clearing that margin in the first place) in case of new licenses (FNC, 2003). This legislation supported by the Comprehensive National Strategy (CNS) for socioeconomic development (1999 - 2002) which formulated and enacted by the Federal Government (FNC, 2003). Nevertheless, no research has been undertaken to evaluate the importance of farm trees in rural livelihoods in Sudan. Moreover, widely differing and often contradictory claims about the livelihood impacts of farm trees have been widely reported in the literature, some authors (e.g. Luedeling and Neufeldt, 2012; Bayala, 2013; Bayala et al., 2014; Mbow et al., 2014; Dessie et al., 2019) mentioning that there is an increasing scientific interest in understanding the contribution of trees on farms to farmers’ livelihood.

The fundamental appeal of farm trees is that, in addition to addressing environmental concerns such as deforestation and climate change (Kiyingi et al., 2016), farm forestry realized as a tool for improving livelihoods of the rural communities through supplying wood products market (FAO, 2001), which could encourage the rural poor households to participate in establishment of farm trees and could improve their livelihoods and alleviate their poverty (Oksanen et al., 2003). However, studies evaluating the impact of farm trees on household livelihoods have largely focused on commercial plantation forests and their role on rural livelihoods is
ambiguous (Kiyingi et al., 2016). On the one hand, some authors (including Barlow and Cocklin, 2003; Oksanen et al., 2003; FAO, 2011; Kiyingi et al., 2016) have argued that the share of plantation investment correlates with potential benefits, through increasing farm income, diversification of income, job creation and access to credit services. On the other hand, a number of authors (including McElwee, 2008; Naburs et al., 2014; Szuleka et al., 2014) reported that poverty levels are higher than average in areas where plantations have been established by farmers. However, there are few studies (e.g. Nsiah, 2010) evaluated the contribution of farm plantation to the livelihoods of farmers in Africa (Kiyingi et al., 2016; Gizachew, 2017; Dessie, 2019) and there is still a large gap in the literature (Chirwa and Mala, 2016). Such information is important and necessary for providing the policymakers with feedback for policy adjustment and thus helps informing the design and development of future forestry and/or agricultural projects which target farmers for improving their rural livelihoods. Thus, the objectives of this study were to: (i) assess the share of farm trees in farmers’ total annual income; (ii) determine and analyze the factors influence the farmers’ decision to plant trees in their farms; and (iii) identify the attitudes and perception of farmers towards trees planting on farms.

2. Methodology

2.1. The Study Area

The study was conducted in Eastern Galabat locality in Gedaref state in Sudan. This locality lies between longitudes 35° 31’ and 36° 09’ E; and latitudes 12° 59’ and 13° 33’ N. The total population of Eastern Galabat locality is 160,623 (Sudan Central Bureau of Statistics, 2012). The study area is characterized by its highly fertile clay soil for sesame and sorghum production. The annual rainfall concentrates in a single relatively short summer season during June to September, and amounts to about 670 mm. Temperature ranges from a mean minimum of 21°C in January to a mean maximum of 36.4°C in April and May. The type and distribution of trees across the study area is largely dependent on rainfall amount and soil type. The main dominant trees include: Acacia seyal var. seyal, A. Senegal, A. millifera, A. nubica, and Balanites aegyptiaca. Tree products (wood and non-wood) have a large and expanding market for charcoal and fuelwood because almost all households use biomass as the main source of energy. Agriculture is the main livelihood activity, followed by livestock rising in the traditional seasonal transhumance pattern (the practice of moving livestock from one grazing ground to another in a seasonal cycle). Gum Arabic production and trading forests products and charcoal production and sale are other traditional income sources. Thus people derive their income from various combinations of the three main forms of land use, viz. cropping, grazing and forest exploitation (Glover, 2005).

2.2. Data collection

This research employed a case study approach. A sample size of 60 farmers was selected purposively from Eastern Galabat locality, Gedaref state in April-May of 2015. Galabat locality was selected due to the implementation of the ministerial decision with regard to 10% tree planting on the agricultural farm. The unit of analysis is a farmer who has trees on his farm. To fulfil the objectives of this study, the selection of farmer was based on: i) ownership of trees on farms, and ii) farm tree products selling for at least one season in one year. The secondary data were collected from available literature (e.g. articles, reports, books, policy briefs and documents) from relevant institutions which provided baseline information for the study. Then a reconnaissance survey was conducted in the study area to enable the researchers to get a better insight of the study communities, to establish contacts with some key personalities within the farmers’ community, and to select field assistants and enumerators.

The criteria used for selecting the assistants and enumerators were based on their knowledge on the study area and their social connection with the farmers’ community. After testing the questionnaire with 10 farmers in the study area, the questionnaire was modified by omission of irrelevant questions and addition of new relevant ones. The questionnaire consisted of questions on farmer characteristics (e.g. age, educational levels, and number of households), farm information (e.g. agricultural land size, type of planted tree species, type of tree products produced, amount of agriculture production, incomes from agricultural production and farm tree) and other source of livelihoods and income from each source.

Before the interview of the farmer, each interviewee was informed about the purpose of the study and his full right to respond to our interview or to refuse it. This ethical issue was important to build confidence between enumerators and the participants as well as to be voluntary process. Focus group discussion was also applied with a total of 5-7 farmers. To cross-check, validate the data, and reveal any ambiguities for the information generated from group discussion, key informants interviews were also employed with forestry officials, heads of community (Omdas), and farmers’ union committee in Gedaref state on the same issues.

2.3. Data analysis

The study employed a combination of qualitative and quantitative methods to analyze the data by using the Statistical Package for Social Survey (SPSS) Version 20 with the aid of Microsoft Excel Version 2010. Descriptive statistical methods were applied to analyze the data on socioeconomic characteristics, income
generation, perceptions and attitudes of farmer households towards establish trees on farms in the form of cash income from trees products was obtained by multiplying the amount of the products sold annually by mean price of the products. Cash income from crop yields was computed by multiplying the amount of the products sold annually by mean price obtained from the local markets. Cash income from commercial farming was computed by multiplying the area of land rented with its price. The cash income from livestock was obtained by asking the respondents to estimate their income from livestock if any. Linear regression analysis was applied to determine a number of factors and their influence on farmer’s decision to plant trees on their farms. Table 1 below explains the description of explanatory variables used in linear regression analysis.

Table 1. Description of explanatory variables used in linear analysis

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAGE</td>
<td>Farmer age</td>
</tr>
<tr>
<td>FEDU</td>
<td>Farmer education</td>
</tr>
<tr>
<td>FHSIZ</td>
<td>Farmer household size</td>
</tr>
<tr>
<td>FLND</td>
<td>Farmer land holding</td>
</tr>
<tr>
<td>FTINC</td>
<td>Farmers total household annual income</td>
</tr>
<tr>
<td>EXT from FNC</td>
<td>Extension services received from Forests National Corporation</td>
</tr>
</tbody>
</table>

For this study, a number of contextual variables were regressed against the dependent variable \(Y\) to estimate the parameters \((\beta_i)\). Equation 1 was used to estimate the explanatory variables:

\[
Y_i = \beta_0 + \beta_1(FAGE) + \beta_2(FEDU) + \beta_3(FHSIZ) + \beta_4(FLND) + \beta_5(FTINC) + \beta_6(EXT \text{ from FNC}) + \varepsilon (1)
\]

Where: \(Y_i\) = the dependent variable; \(\beta_0\) = the intercept term; \(\beta_1, \beta_2, \beta_3, \ldots, \beta_6\) = regression coefficients associated with each explanatory variables; and \(\varepsilon\) = the error term. The dependent variable is area of planted trees on farm.

The independent variable (FAGE) is the farmer age and it was expected that a young farmers has a greater opportunity of adopting new activities (tree planting) than an older one, because he is more willing to or capable of taking risks as suggested by Sidibé (2005). Farmer education (FEDU) measures the level of education. It takes the value 1, if illiterate; 2, if the respondent has Khalwa\(^1\) education; 3, if completed primary education; 4, if completed secondary education; 5, if a university graduate; 6, if have a postgraduate education. Education is thus expected to have a positive effect on the decision to plant trees on farms. Household size (FHSIZ), measures the number of people living in the household. It was expected that the largest number of household are more likely to plant trees on farms. Thus household with many members and with educated head, has higher probability of adopting tree planting (Buyinza 2008). This similar situation occurs for farmers with a large land holding (FLND) and within a higher income (FTINC). It’s expected that farmers owning big portions of land may face less pressure to plant trees on their farms and this may positively affect planting trees on farm. Extension services from FNC (EXT from FNC), measure the contact of farmers with FNC and their recipients of any kind of extension from FNC. It was hypothesized that (EXT) positively influenced farmer’s decision to plant trees on their farms.

3. Results

3.1. Socioeconomic characteristics of the farmers

The average age of the farmer is 53.25±1.8. The majority of respondents (58.3%) are at age above 50 years (50-87 years), while only 11.7% and 30% at age range of 18-38 and 39-50 years, respectively. The average of household size is 8±0.16 members. The education profile illustrates that 3%, 42%, 10% and 4% of the respondents have Khalwa, primary, secondary and university education, respectively, while 41% is illiterate. The study findings also reveal that the majority of respondents (61.7%) own farm land size with average of (139.65±23.9) Feddan\(^2\), 1.7% with an average of (100±34.7) fa, 33.3% with an average of (300 ± 23.4) fa, and 3.3% with average of more than (500±101) fa. Regarding the farm land ownership, the study results explain that the majority of the respondents (61.7%) are the landlords, 3.3% are renters, 28.3% are inherited for their elders, and 6.7% are sharing land with relatives.

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\(^1\) A Khalwa is a religious school in which Muslims learns the Holy Goran and Goran studies

\(^2\) One Feddan is equal to 0.42 ha.
3.2. Share of farm trees in farmer total annual income

The study results in Table 2 indicate that the average annual cash income is US$ 1467±45.6, US$ 2481±22.9, US$ 171±123.8 and US$ 893±12.6 from farm trees (wood and non-wood forest products), agriculture, livestock and land renting, respectively. The same table illustrates that farmer's total annual average cash income is US$ 5012. The study findings shows that agriculture is the first most important contributor to farmer’s annual total cash income (52%) followed by farm trees (31%), land renting (13%) and livestock (4%).

<table>
<thead>
<tr>
<th>Economic activity</th>
<th>Annual average income (US$ ± Std. Error)</th>
<th>Share of total annual farmers income (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>2481 ± 22.9</td>
<td>52</td>
</tr>
<tr>
<td>Farm trees (wood &amp; non wood products)</td>
<td>1467 ± 45.6</td>
<td>31</td>
</tr>
<tr>
<td>Land renting</td>
<td>893 ± 12.6</td>
<td>13</td>
</tr>
<tr>
<td>Livestock</td>
<td>171 ± 123.8</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>5012</td>
<td>100</td>
</tr>
</tbody>
</table>

\( n = \text{number of respondents}; 1\text{US$} = 7.5 \text{SP (Sudanese pound)} \) in 2015

3.3. Factors influencing farmers’ decisions to plant trees on farms

The results of the linear regression analysis in Table 3 show that the farmer land size (FLND) \((P = .000\)), farmer total income (FINC) \((P = 0.042\)), farmer household size (FHSIZ) \((P = 0.009\) and extension services from FNC (EXT from FNC) \((P = 0.001\) are significantly and positively correlated with farmers’ decision to plant trees on farm at 5% level of significance \((P<0.05\)). However, farmer age (FAGE) and farmer educational level (FEDU) are not significantly associated with farmer decision to plant the trees on farms. The adjusted \(R^2\) was found to be 0.557, which indicates that 55.7% of the variation in dependent variable is explained by the incorporated independent variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Partial regression coefficient</th>
<th>Std. Error</th>
<th>Beta</th>
<th>t-value</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>112.027</td>
<td>165.304</td>
<td>0.678</td>
<td>0.501</td>
<td></td>
</tr>
<tr>
<td>FAGE</td>
<td>-2.471</td>
<td>1.608</td>
<td>-0.185</td>
<td>-1.536</td>
<td>0.130</td>
</tr>
<tr>
<td>FHSIZ</td>
<td>13.183</td>
<td>4.828</td>
<td>0.336</td>
<td>2.731</td>
<td>0.009</td>
</tr>
<tr>
<td>FEDU</td>
<td>20.452</td>
<td>26.930</td>
<td>0.080</td>
<td>0.759</td>
<td>0.451</td>
</tr>
<tr>
<td>FLND</td>
<td>0.245</td>
<td>0.035</td>
<td>0.708</td>
<td>7.050</td>
<td>0.000</td>
</tr>
<tr>
<td>FINC</td>
<td>-0.001</td>
<td>0.000</td>
<td>-0.213</td>
<td>-2.089</td>
<td>0.042</td>
</tr>
<tr>
<td>EXT from FNC</td>
<td>-56.859</td>
<td>41.477</td>
<td>-0.131</td>
<td>-1.371</td>
<td>0.176</td>
</tr>
</tbody>
</table>

Note: Bold values contribute significantly at \(P<0.05\); \(R^2 = 0.557\)

3.4. Farmers’ attitudes and perceptions towards trees planting on farms

Table 4 reveal that the benefits of farm trees as indicated by the farmers, which include: increased income (95%), increase in productivity of agricultural crops (90%), increased availability of firewood (88%) and reduced damage of trees on crops (80%). These high percentages of tree benefits indicated by farmers obviously explain the fact that they are aware of tree environmental services other than income generation. However, the findings in the same table 4 also illustrate that the farmers have negative/risk perceptions towards farm trees. These risk perceptions are coming from the idea that trees on farms increase pest outbreaks (78.3%) and lead to water scarcity on farms (100%).

<table>
<thead>
<tr>
<th>Perceptions and attitudes towards trees planting on farms</th>
<th>Frequency and percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting trees on my farm will increase my cash income</td>
<td>57 95 3 5</td>
</tr>
<tr>
<td>Planting trees on my farm will reduce the crops damage</td>
<td>48 80 12 20</td>
</tr>
<tr>
<td>Planting trees on my Farm increase pest outbreaks</td>
<td>47 78.3 13 21.7</td>
</tr>
<tr>
<td>Planting trees on my farm increase the productivity of agricultural crops</td>
<td>54 90 6 10</td>
</tr>
<tr>
<td>Planting trees on my farm leads to water scarcity on my farm</td>
<td>0 0 60 100</td>
</tr>
<tr>
<td>Planting trees on my farm will increase the availability of firewood</td>
<td>53 88.3 7 11.7</td>
</tr>
<tr>
<td>Awareness of forest policy and law regarding tree planting on farmlands</td>
<td>44 73.3 16 26.7</td>
</tr>
<tr>
<td>Forest policies and laws towards trees planting on farms are effective</td>
<td>26 43.3 34 56.7</td>
</tr>
<tr>
<td>Awareness of silvicultural operations for farm trees</td>
<td>17 28.3 43 71.7</td>
</tr>
<tr>
<td>I am aware with the importance of trees on farm</td>
<td>54 90 6 10</td>
</tr>
<tr>
<td>I have a will to plant trees on my farm</td>
<td>55 91.7 5 8.3</td>
</tr>
</tbody>
</table>

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The study findings also show that the majority of farmers (71.3%) have no idea on tree silvicultural operations, while only 28.3% familiar with some of silvicultural practices (e.g. pruning and thinning) which is based on their own experience. The study results also illustrate that, the majority of respondents (90%) aware about the importance of trees on farms in the face climate change. 91.7% of the respondents state that they have a will to plant trees on their farms if they have been supported with financial and technical assistance (Table 4).

4. Discussion

4.1. Share of farm trees in farmer total income

Farm tree planting is a relatively recent phenomenon for some of the study population. Nevertheless, it has become an important income diversification activity for the farmers. This section highlights the financial contribution of farm trees to the income streams of the farmers and the importance of this income component to the farmers’ livelihoods. One of the benefits of integrating trees into existing farms is the opportunity to improve farm incomes and thus livelihoods (Tonts et al., 2001; Dessie et al., 2019).

The income from the sale of various farm tree products contributed as much as US$ 1467 of total farmer’s income that own farm tree (Table 2). This amount accounts for 31% of total farmer income and also represents the second most important income generating activity after agriculture for these farmers. Income from farm trees seeks to broaden the income spectrum of the farmer and therefore allows them some level of flexibility and greater income security in the face of declining returns from traditional food and cash crop (e.g. grain and sesame) production as a result of fluctuating commodity prices. This finding mirrors the results of Nsiah (2010) who argued that, the income gained from tree planting can contribute to farmers’ daily income and consumption in many developing countries. However, Angelsen and Wunder (2003) have raised doubts on the potential of forest regarding livelihood improvement, arguing that this potential is currently small. In contrast, Lopez-Gomez et al. (2008); Tesfaye et al. (2010); Adam et al. (2013); Gizachew (2017) indicated that forest income could raise the income levels of poor households closer to the level of the wider community, and sometimes improve their livelihoods and lift people out of poverty.

4.2. Factors influencing the farmers’ decisions to plant trees

The results of linear regression analysis show that farmer household size (FHSIZ) is positively and significantly associated with farmer decision to plant trees on farm. This may be due to the fact that a large family offers better availability of labor in areas where household depends on family labor for farming activities. Large families in traditional farming areas are found to be important for increasing income generation options (Fahmi et al., 2015; Dessie et al., 2019). In addition to that, there are more mouths to feed, and thus, more family members are involving in livelihoods diversification within the available strategies (Yirga, 2007; Deressa et al., 2009). This result is also consistent with Munner (2008) who found that the family size (≥ 11) members in North Kordofan, Sudan were more innovative in practicing agroforestry system than family with small size. However, this study result contradicts with Jenbere et al. (2012) who stated that family size is negatively and significantly correlated with decision on tree planting. Similarly, Kulindwa (2016) in Ghana found that when the family size increases, usually through additional children, parents redivide a piece of farm land among their children after they grow up, in an effort to help them get a good start in life.

Farmer land size (FLND) is significantly and positively correlated with farmer decision to plant tree on farm. This suggests that once the decision to plant trees on farm is taken, land right becomes crucial to the farmer in the study area. Similarly, Kulindwa (2016) in Tanzania, Danquah (2015) in Ghana and Asharf et al. (2015) in India reveal a positive association between the landholdings size and farmer decision on planting trees on farm. Another determinant of farmer decision to plant trees on farm is total farmer income (FINC). The total farmer income is positively and significantly associated with his decision to plant trees on farm. This finding is quite expected giving the fact that when a farmer has high income he will has a greater chance to adopt new livelihood strategy for making a better life including tree planting, because his economic situation will make him possible to take risk for adopting new ideas. This finding mirrors the results of Kakuru et al. (2014) who stated that farmer total income is the main driver for adoption of on-farm tree planting in Kibaale district, Uganda.

Extension services provided by Forest National Corporation (EXT from FNC) were positively and significantly correlated with farmer decisions on planting farm trees. This may be due to the fact that extension services may increase the awareness of farmers to plant trees. This result is in line with Fahmi et al. (2015) who reported that farmers who didn’t receive extension services and limited support from agricultural organization were unlikely to plant Acacia senegal trees in their farm.

Some farmer characteristics, including age (FAGE) and education level (FEDU), did not have significant effect on their decision on trees planting in the farms. In contrast, Nsiah (2010) reported that the age of the household head farmer was highly significant in explaining the farm household decision to establish farm forest plantation in Ghana, where he found that relatively older farmers tend to plant trees as they engage in economic activities that have long term asset accumulation potential.

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4.3. Farmers’ attitudes and perceptions towards trees planting on farms

The attitudes towards tree planting on farm were mostly positive, meaning that farmers associated more positive than negative outcomes with farm tree planting. This confirms the results of Meijer et al. (2015) who reported that farmers in Malawi highly value trees on their farms. However, the results of this study also indicate that there are negative/risk perceptions connected to farm trees planting such as water scarcity. This may be due to the fact that the study area suffers from the scarcity of rainfall over the last decade. Gaafar (2005) concluded that A. senegal agroforestry systems in Sudan result in competition for water resources between the crops and trees, which is contradictory to the general aims of agroforestry practice.

To facilitate farm trees planting in such situations, the extension services offer by Sudan’s Forest National Corporation (FNC), should include more technical and research oriented issues of tree-crop interaction and eco-physiological adaptation, as well as climatic and edaphic factors (Fahmi et al., 2015) as the majority of the farmers in the sample are willing to plant trees and aware with the environmental importance of trees. The majority (71.7%) of the farmers have no knowledge on silvicultural operations for A. Senegal and A. seyal which have been planted on the farm. This means that the most common management activity is often limited to harvesting of trees products. Therefore extension services should include training on how to run the tree management practices in order to secure the intermediate products for farmer income generation an reduce tree competition with farm crops for water and nutrients.

4.4. Policy Implications

The study illustrates that farm trees make significant contribution to total income and is ranked as the second important source of income after agriculture. Many farmers have adopted farm trees as a key livelihood strategy to increase and diversify their income sources, and strengthen their capacity and ability to improve their livelihoods. However, some factors induce farmer’s decision to plant trees on their farms. The results show that farmer’s decision to plant trees on farm is positively and significantly influenced by an increase in farmer’s landholding, size of the household, amount of total income, and extension services received from the FNC.

The study indicates that the respondents are aware with the benefits farm trees planting, and thus their attitudes towards farm trees are mostly positive. This means that farmers associated more positive than negative outcomes from farm tree planting regardless of their socioeconomic characteristics. However, there are risk perceptions associated with planting trees on farm identified by the farmers. These include insects out break and water scarcity.

Further studies should include the analysis of current forest policy and forest products market and their impact on farm trees livelihoods aspects- income generation. Additionally, Forest National Corporation (FNC) should not overlook the socio-economic characteristics of the farmers when farm trees planting program is initiated in the rest of region.

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