Forthcoming in: Muradian, R. and L. Rival (Eds.) (2012) Governing the provision of ecosystem services. Heidelberg: Springer.

On-Farm Tree Planting in Ghana's High Forest Zone: The Need to Consider Carbon Payments

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1. Introduction

In 1994 Ghana reformed its forest policy by enacting the Forest and Wildlife Policy which encouraged economic tree planting (FC 2006a). After that the then Minister of Lands, Forestry and Mines launched several economic tree planting programmes in the Offinso Forest District (FD) in the Ashanti Region. These efforts were strengthened in 2001 when the government launched the National Forest Plantation Development Programme to stimulate reforestation through the establishment of forest plantations and the planting of trees on farming land (FC 2008). Section 3(3) of the Forest Plantation Development Fund Act 2000 makes provision for timber ownership rights to individuals who plant trees on farmlands (Agidee 2011). A revision of the Timber Resource Management (Amendment) Act 2002 (Act 617) (FC 2006b) led to tree ownership being vested in the farmer or planter of the tree. This represented an exemption to common practice in Ghana of tree ownership being vested in the state. Since then, on-farm tree planting initiatives have mushroomed throughout Ghana's high forest zone. In response to farmers' interest, both state actors (e.g. the Forest Services Division (FSD) of the Ghanaian Forestry Commission (FC) and the Forest Research Institute of Ghana (FORIG)) and non-state actors (e.g. NGOs, timber and mining companies) stimulated tree planting among small farmers in off-reserve areas.[1] Many land-owning farmers in Ghana's high forest zone benefited from the policy reforms and incentives from private companies and governmental and non-governmental organisations and have adopted various agroforestry[2] models over the years.

Farmers and supporting organisations in Ghana are facing several challenges in the implementation of these on-farm tree planting schemes, with suboptimal livelihood benefits being the result. According to Boni (2006), these challenges include extra work and costs involved in tree planting and maintenance, the absence of short-term benefits due to the time gap between investment (planting and weeding) and profit (from harvesting), bureaucratic procedures to obtain loans for tree planting and land rights documentation, ambiguous legislation regarding tree ownership and insecure timber rights for tenant farmers. Given that it is a scheme that is potentially eligible for carbon payments, it is important to gain a greater insight into the livelihood implications of these challenges. This paper aims to provide this insight by addressing the questions of (i) how on-farm tree planting contributes to rural peoples' livelihoods, (ii) what are stakeholders' perceptions regarding the performance of

[1] Ghana's forests are divided into reserved and unreserved forests, commonly denoted as on and off-reserve areas.
[2] Following Somarriba (1992, p. 240), agroforestry is defined in this paper as a form of multiple cropping in which at least two plant species interact biologically, with at least one of them being a woody perennial and at least one plant species is managed for forage, annual or perennial crop production.

these schemes and (iii) what strategies can be followed to improve the livelihood outcomes of tree-planting schemes. The next section of the paper provides information about the methodology and characteristics of the study area. After that we briefly discuss the theories that underpin this paper. This is followed by a presentation and discussion of the results as regards livelihood benefits and farmers' perceptions of the scheme. The final section concludes the paper and makes recommendations for enhancing the contribution of Ghana's on-farm tree planting to rural livelihoods.

2. Methodology and background to the study area

Fieldwork for this study was carried out between August 2009 and November 2010 in Ghana's high forest zone. Below we justify the selection and describe the main socioeconomic characteristics of the study sites and describe the methods used to gather the data.

2.1 Selection of the study areas

Three forest districts with more than a decade of history with on-farm tree planting programmes facilitated by both state and non-state actors were selected: the Asankrangwa and Sefwi Wiawso FDs in the Western Region and Offinso FD in the Ashanti Region (Figure 1). In each forest district, two villages actively involved in on-farm tree planting were selected: Oda-Kotoamso and Akyekyere (Asankrangwa FD), Sefwi Abrabra and Sefwi Bopa (Sefwi Wiawso FD) and Nkwaankwaa and Nkenkaasu (Ofinso FD) (Figure 1).

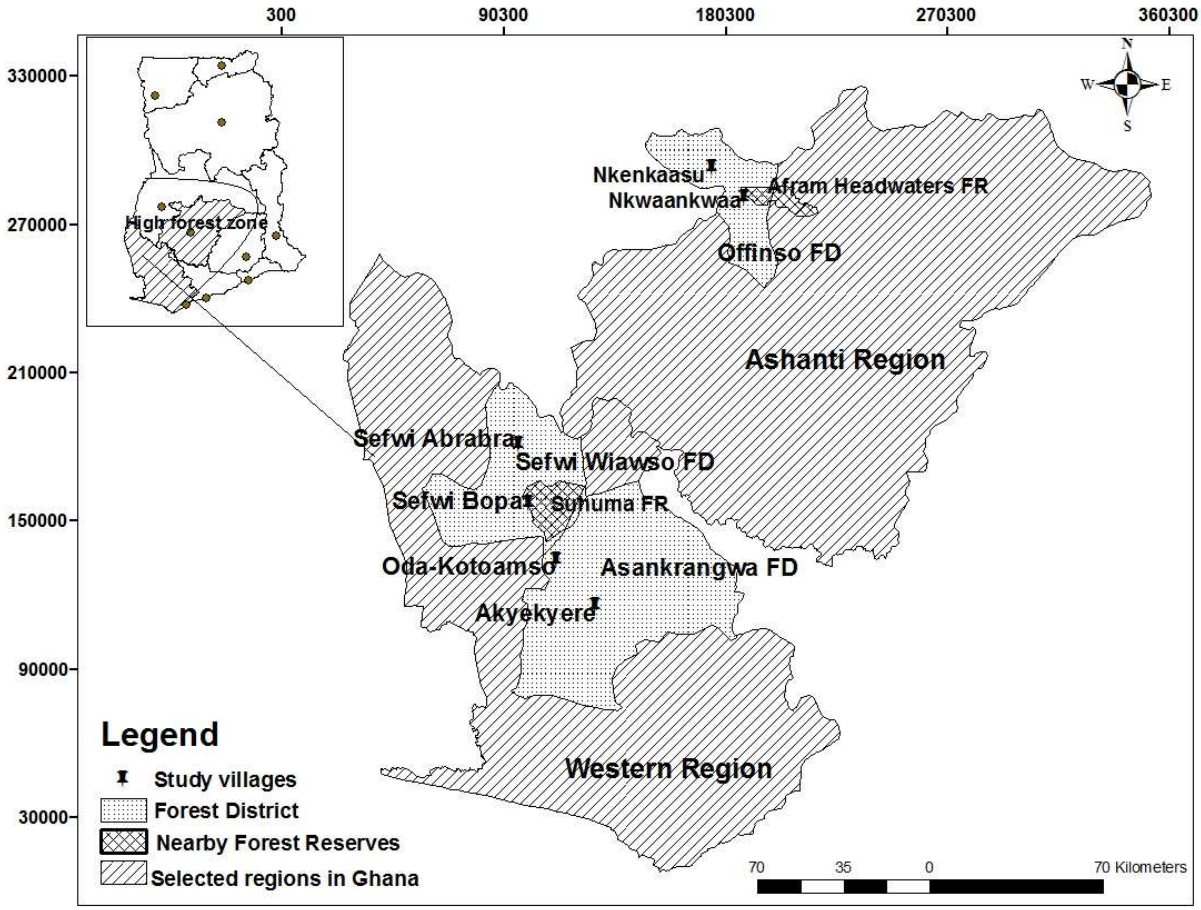

Figure 1: The study sites

Table 1: Four on-farm tree planting modes identified in Ghana's high forest zone

Mode 1: Timber company-supported on-farm tree planting:
• Farmers in the Samartex concession area are supported by the Samartex Agroforestry Unit (SAU), which is part of the company's Forest Development Division (FDD), in the planting of timber trees on farmlands. Stakeholders (chiefs, farmers, company) jointly agree on the tree-planting modalities. • The SAU negotiates with chiefs to release land to farmers interested in tree planting and mediates in obtaining titles of the tree farms. • In the case of farmers who use individual or family/clan lands for tree planting, their share in the benefits is based on 100% of crops (all types) and 100% of the tree benefits. • In the case of farmers who use the chief's land, benefit-sharing regarding timber trees is based on 33% for the chief/landlord and 67% for the farmer, and 100% of food crops for the farmer. • In the case of planting timber trees in cocoa farms under a sharecropping arrangement, benefit-sharing is based on the *Abunu* sharing system (50% for the landlord and 50% for the tenant for both timber and crop benefits). • The supporting timber company has the first right to buy the planted trees at prevailing market prices. • Identified in the Asankrangwa FD.
Mode 2: NGO-supported on-farm tree planting:
• The NGO facilitates on-farm timber tree planting in selected communities as part of its project mandates. • Farmers use individual or family/clan lands for tree planting, and are entitled to a 100% share of the crops (all types) and a 100% share of the tree benefits. • Farmers find their own market for planted timber trees. • Identified in the Sefwi Wiawso FD.
Mode 3: State government-supported on-farm tree planting initiative:
• The government employs workers to plant timber trees in both on and off-reserve areas. Facilitated by the Forest Services Division of the Forestry Commission and the District Assemblies. Launched in January 2010. The government (investor) uses chief's land in off-reserve areas, with benefit-sharing being based on 33% for the chief/landlord and 67% for the investor for tree benefits and 100% of the food crops for the workers. • Workers are paid for tree planting and maintenance, but have no benefit in terms of trees. • Identified in the whole high forest zone.
Mode 4: Farmer initiative with little government support:
• Farmers plant trees on farms on their own initiative, incentivised by policy reforms and the importance of economic trees, and with a little support from the government (FSD/FC). • Farmers use individual or family/clan lands for tree planting and therefore receive 100% of the crop benefits (all types) and 100% of the tree benefits. • Farmers find their own market for planted timber trees. • Identified in the Offinso FD.

The selection of the villages was based on the prevalence of on-farm tree planting modes under different kinds of institutional support (Table 1). These modes encompass different modalities, ranging from planting trees in pure stands to various agroforestry systems. The latter combine the planting of exotic tree species (mainly teak (*Tectona grandis*) and cedrela (*Cedrela odorata*)) and indigenous tree species (mainly ofram (*Terminalia superba*), emire

(*Terminalia ivorensis*) and African mahogany (*Khaya ivorensis*)) with perennials and food crops. Cocoa (*Theobroma cacao*) and oil palm *(Elaeis guineensis*) are the most common permanent crops, but black pepper (*Piper nigrum*), cola (*Cola nitida*) and orange *(Citrus sinensis*) are also inter-planted with trees. The food crops in question are mainly plantain, cassava, vegetables, maize, cocoyam and yam.

In Asankrangwa FD farmers were involved in a private reforestation scheme, i.e. a company-community partnership with Samartex Timber & Plywood Co. Ltd. (Samartex in the rest of this paper). This firm – one of the largest timber companies in Ghana, which became FSC-certified in 2008[3] – supports farmers in tree planting as part of its corporate social responsibility policy. In order to realise its sustainability and social responsibility aims, Samartex established the Forest Development Division (FDD) with the aim being to (i) collaborate with communities and farmers to develop agroforestry systems and plantations, (ii) establish plantations on degraded lands, and (iii) promote the development of non-timber forest products (NTFPs) such as *Thaumatoccocus danielli*, which is used as a natural sweetener, and honey. To realise the first aim, a pilot project known as Oda-Kotoamso Community Agroforestry Project (OCAP) was set up in 1997[4] and later expanded to other communities in the firm's concession area under a public-private partnership (PPP) with the German Agency for Technical Cooperation (GTZ) known as the GTZ/Samartex PPP (Suglo 2009). Within this context, efforts were made to grant property titles to the tree-planting farmers (with 212 farm plots mapped and processed for registration by November 2010), to inform farmers and traditional authorities about land rights and rules that regulate tree planting in off-reserve areas, and to explore opportunities for farmers to engage in carbon credit schemes.

The villages of Sefwi Abrabra and Sefwi Bopa in Sefwi Wiawso FD were selected because they are representative of the 59 villages in Sefwi Wiawso FD that were supported by Ricerca e Cooperazione, an Italian NGO which stimulated tree planting on farmlands under its Forest Resource Creation Project from 2000 to 2004. The general aims of this NGO – established in 1985 and active in Ghana since 1987 – centre on safeguarding biodiversity and the cultural heritage of indigenous cultures and on promoting fundamental human rights and good governance. During its presence in the study area, the NGO promoted tree planting on crop land, in degraded cocoa plantations and in oil palm plantations, with a view to reducing pressure on natural forests and improving soil fertility by planting nitrogen-fixing tree species (Da Re 2005). It did so by organising farmers into tree-grower associations, providing seedlings and promoting agroforestry by providing technical advice and equipment. Moreover, it promoted alternative livelihoods, like black pepper cultivation, beekeeping, vegetable growing, grasscutter rearing and snail farming (Ibid., p. 24-25). Due to low returns resulting from a lack of institutional capacity and policy support, suitable credit schemes, markets, and skills and sustainable interest among beneficiaries (who preferred to invest in perennials like cocoa and oil palm), the project was discontinued in 2004 with no exit plan that could guarantee follow-up by the FSD (Da Re 2005, p. 25; Mr Jones, former RC project officer, pers. comm.).

Offinso FD was selected because there are ten villages in this forest district where a good number of farmers have adopted on-farm tree planting through their own efforts, with some support from organisations like the FSD. Farmers organised themselves into the Offinso Teak

[3] URL: info.FSC.org.
[4] URL: www.samartex.com.gh, retrieved November 24, 2011.

Growers Association (OTGA), the leadership of which maintains good contacts with the FSD. Via the OTGA leadership, occasional support from the FSD was obtained in the form of training and mediating in tree seedling supply. Overall, however, tree-planting farmers in this forest district rely on their own or on hired experts to survey and document their land and to find a market for their mature timber.

The fourth, government-supported, tree-planting mode in Table 1 has not been included due to it being too recent an initiative (initiated in January 2010) to enable any meaningful data collection.

2.2 Socioeconomic characteristics of the study areas

Agriculture is the major economic activity in all study sites, employing 70% to 85% of the people who are mostly peasant farmers. Traditionally engaged in slash-and-burn cultivation (Quansah et al. 2001), increasing scarcity of farming land forced farmers to engage in sedentary farming (Da Re 2005). In the Asankrangwa and Sefi Wiawso FDs, cocoa and oil palm are the major cash crops, although coffee is also grown. In the much dryer Offinso FD, prospects for cocoa farming are less favourable. Oil palm is all-weather resistant, but the region has a problem with the provision of good seeds.[5] Consequently, farmers focus mainly on vegetables (tomatoes, peppers, garden eggs and okro) and, to a lesser extent, on cashew and timber trees as their main cash crops. Particularly in this region, timber has become an interesting option due to declining cocoa yields. The differences in ecological circumstances and agricultural opportunities mean that in the first two areas timber trees are mainly inter-planted with cocoa trees, whereas they are planted in pure stands in Offinso FD, with a preference for fire-resistant teak (*Tectona grandis*). In all areas the major staple crops are cassava, cocoyam and plantain. In Offinso FD farmers also cultivate maize, vegetables and yam.

The villages in Asankrangwa and Offinso FD are close to regional market centres. Asankrangwa town is a large market centre, located 4-5 km from the two villages. Nkenkaasu is one of the major market centres in Offinso FD; Nkwaankwaa village is about 5 km from Abofour town which has a vibrant weekly market. In both districts there are ample opportunities for market-oriented production. This is less so for the more isolated study villages in Sefwi Wiawso FD, which have a poor road connection with Sefwi Wiawso town that has a large market. In these villages trading mainly takes place through middlemen who come to the villages during the peak of the harvesting season.

2.3 Research methods

Data was obtained through a household survey of 106 on-farm tree planting smallholders from the six villages (Table 2), open-ended interviews with key informants and some validations through group discussions in the villages and additional key informant interviews. Key informants included chiefs and a queen mother, project officers affiliated to supporting organisations, FSD officers and leaders of tree-planting associations and steering committees. In each village, respondents were randomly selected from the group of tree planting smallholders who were identified with the help of farmer leaders. Of the respondents 61% were males and 39% females, which corresponds with the overall gender ratio in on-farm tree planting. Three village level focus group discussions were held with farmers, during which

[5] URL: http://offinso.ghanadistricts.gov.gh, retrieved November 24, 2011.

Table 2: Overview and characteristics of the study sites

Location of forest dist.	Study villages	No. of resp.	Administrative districts	Stool land owners	Forest district	Region	Eco-zone	Prevailing tree-planting scheme
Lat. 5°48'0''N; Long. 2°26'0''W	Oda-Kotoamso Akyekyere	16 14	Amanfi West	Asankrangwa Akyekyere	Asankrangwa	Western	Wet evergreen to moist evergreen forest	Company-community partnership
Lat. 6^0 N to 6^0 30' N; Long. 2^0 45' W to 2^0 15 W	Sefwi Abrabra Sefwi Bopa	32 21	Sefwi Wiawso / Akontombra	Sefwi Asanteman	Sefwi Wiawso	Western	Moist evergreen to moist semi-deciduous forest	NGO-facilitated tree-planting and agroforestry scheme
Lat. 6° 45′N to 7° 25′ N Long. 1° 32′W to 1° 48'W	Nkwankwaa Nkenkaasu	9 14	Offinso	Offinso	Offinso	Ashanti	Moist semi-deciduous, semi-evergreen forest	Farmer's own initiative

Tool 4 of the PROFOR 'Poverty-Forests Linkages Toolkit'[6] was employed. This tool is a qualitative method employed for one group of 10 males and one group of 10 females per village, through which the participants list their income-generating economic activities and clarify the proportion of income generated by each of them by assigning 20 stones (representing 'money') to the listed activities. This was done twice for each group, for both cash and non-cash income respectively. Finally, in-depth interviews were held with six smallholders from the three forest districts with a view to obtaining detailed data on planting and maintenance costs and revenues from the scheme.

3. Theoretical outlook

This study uses the sustainable livelihood approach based on Carney (1998) and Scoones (1998, 2009) to analyse the livelihood effects of on-farm tree planting. Attributes considered in this study include assets (natural, human, financial, physical and social capitals) formed through the on-farm tree planting schemes. The sustainable livelihood approach also considers stresses and shocks that can affect planted trees and crops (in this case drought, fire and timber theft), as well as fluctuations in markets (prices of crops and timber). For an on-farm tree planting scheme to act as a sustainable livelihood, it should, among other things, include timber species like teak that can withstand drought and fire outbreaks. The tree planting scheme should also incorporate all kinds of marketable annual and permanent crops in an agroforestry setting, in order to generate income during the period between tree planting and harvesting.

In terms of livelihood potential, we draw on the distinction made by Sunderlin et al. (2005) between poverty mitigation and poverty elimination. In the first case (poverty avoidance or mitigation), forest resources serve as 'safety nets' or 'gap fillers', whereas, in the case of poverty elimination forest, resources help lift the household out of poverty by functioning as a source of permanent increase in income, assets, services, civil and political rights, voice and the rule of law. In this paper, we emphasise the prospects for pulling people out of poverty through the creation of a high value forest resource by economic tree planting on farmlands.

Several studies have been carried out that have shed light on the actual and potential livelihood effects of reforestation and agroforestry schemes. For instance, Smith and Scherr (2003) highlight the cash and non-cash income benefits from food, fuel and construction material, inputs for farming (e.g. green manure and fodder), and environmental services (e.g. windbreaks, erosion prevention, soil fertility enhancement and soil recuperation). In some cases, smallholder tree planting even allows farmers to accumulate assets that can be invested in farmland and children's education or be used to pay off debts (Saxena 1997, cited in Smith and Scherr, 2003). Chambers et al. (1993) stress the role of trees in dealing with contingencies, either through direct use, sale of timber for cash, or as a source of savings and security. At the same time, several livelihood risks inherent in tree planting have been noted, such as a reduction of the land available for crop production (Smith and Scherr 2003), theft (Kusters et al. 2008) and fire (Insaidoo et al. forthcoming). More recent literature stresses the notion that the economic feasibility of agroforestry and small-scale plantations, as well as their livelihood benefits, can be increased by their engagement in the carbon market (e.g.

[6] The Program on Forests (PROFOR) is a multi-donor trust fund hosted by the World Bank which shares the goals of enhancing forests' contribution to poverty reduction, sustainable development and protection of environmental services. See http://www.profor.info/profor/about-us.

Swallow et al. 2006, Schrot and McNeely 2011). This issue will be addressed in more detail in Section 6.

4. Contribution of on-farm tree planting to participants' livelihoods

This section analyses the contribution made by on-farm tree planting to the five livelihood assets of human, social, natural, financial and physical capital.

4.3.1 Human capital

Figure 2 presents the competencies respondents claimed to have acquired through their contacts with partner organisations that supported them in tree planting. The primary skill acquired is in planting and agroforestry techniques, followed by tree nursery establishment techniques. Remarkably, this score is lower among the company-supported tree growers in Asankrangwa FD than among the farmers in Offinso FD who receive minimal support from the FSD. This can be explained by the strong leadership of the Offinso Teak Growers Association to which the tree-planting farmers are affiliated, and the close contacts that these leaders maintain with the FSD.

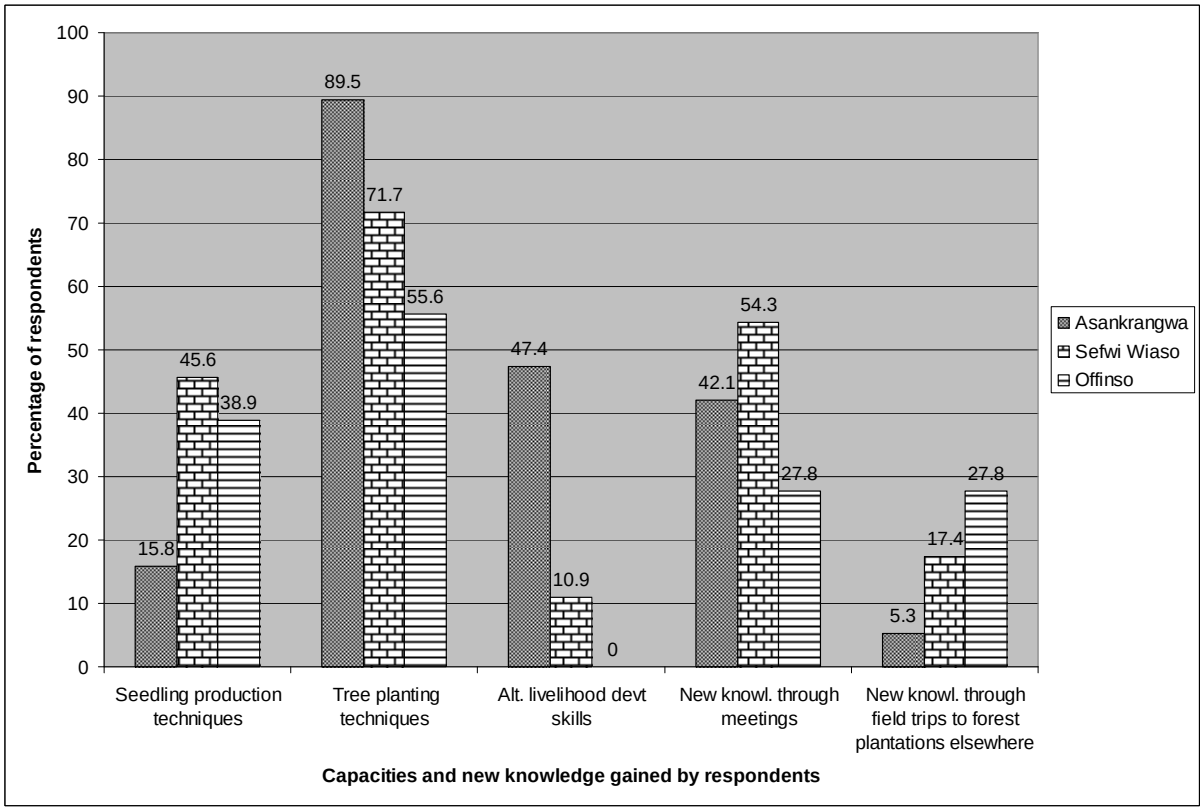

Figure 2: Respondents' indication of competencies (human capital) acquired in the tree planting project.

Engaging in tree planting also involves attending meetings and workshops in which information and training are given that add to farmer's skills, including in Offinso FD. Training in alternative livelihood ventures applies only to the externally supported modes, mentioned more frequently in relative terms by the company-supported tree growers in Asankwangwa FD (47%) than the NGO-supported ones in Sefwi Wiawso (11%). Supporting

organisations, including the OTGA in Offinso FD, also organise field trips to forest plantations elsewhere, and this was also referred to as a source of acquired skills (Figure 2).

Survey results indicate that training or guidance in tree planting and/or agroforestry techniques has resulted in increased crop yields, income and fodder for animals, as well as improved skills in farming. In Asankrangwa, Sefwi Wiawso and Offinso FDs, 71%, 21% and 29% of respondents respectively indicate higher crop yields from both agroforestry and farm plots as a result of guidance in agroforestry and tree planting skills. Respondents in Offinso FD (86%), who are actively involved in small ruminants (sheep and goats) rearing, indicate that guidance in agroforestry techniques from the FSD via their leaders has helped them to improve fodder production for their animals.

4.3.2 Social capital

All three tree planting modes helped create social capital in the form of producer groups and/or tree- grower associations.

Tree farmers in Oda-Kotoamso (Asankrangwa FD) were organised into a group that operated under the OCAP. Until 2004, when financial support from Samartex was ended, the OCAP's steering committee consisted of a nine member executive body (all participating farmers), the Samartex representative who acted as the manager, and a representative of the chief. The local steering committee's tasks included (i) the administration of annual requests for seedlings on behalf of participating farmers (old and new), (ii) mediating in encroachment and boundary disputes, (iii) monitoring illegal felling of timber trees from nearby forests and farmlands, (iv) patrolling to prevent fire outbreaks during the dry season (November to March), (v) distributing bee hives to members who wanted to go into bee keeping, and (vi) monitoring tree planting and alternative livelihood venture activities. The local steering committee still exists and continues to function despite the withdrawal of Samartex's financial support, with a focus on processing annual requests for tree seedlings from the timber company and on protecting the trees and forests in the area against fire and illegal felling.

Tree farmers in Akyekyere (Asankrangwa FD) under the company-community partnership organised themselves into a group under the leadership of the village chief (a tree farmer himself) and his assistant. The two leaders mediate between Samartex and the tree farmers in the village in requests for tree seedlings and bee hives (which they have to pay for since Samartex ended its financial support for the agroforestry project in 2004), free extension services and other needs. This group has no appointed or elected executives or byelaws.

Under the NGO-supported tree planting mode in Sefwi Wiawso FD, the farmers were organised into a group during the period that the NGO (Ricerca e Cooperazione) actively facilitated tree planting. The group's executive body coordinated project management with the NGO in order to ensure a smooth implementation of tree-planting activities by participating farmers. The executives mobilised members for meetings, training workshops and other group-based activities organised by the project. The producer group dissolved when the NGO ended its activities in the region, and the few farmers who continued to plant trees after the exit of the project did so individually.

In Offinso FD, the majority (73%) of the respondents are members of the Offinso Teak Growers Association (OTGA) that is composed of on-farm tree farmers from ten villages in Offinso FD. The OTGA liaises with the district FSD office for the provision of technical advice and inputs (e.g. tree seedlings) to its members. The main reason (given by 32% of the

respondents) for individual tree farmers to join the association is to expand their access to external support. One respondent mentioned participation in decision-making and providing a strong voice for the welfare of tree growers as a reason to join. Although the association's requests for support from the FSD do not always generate the expected results, it plays a role in promoting tree planting, as a result of which farmers continue to plant trees annually and the area planted with trees is slowly but gradually expanding.

4.3.3 Natural capital

In focus group discussions, respondents in the Asankrangwa and Sefwi Wiawso FDs indicated that all participating farmers receive timber tree seedlings from their supporting organisations. This is only 17% of the interviewed self-organised farmers in Offinso FD. Most tree growers in Offinso FD obtained the seedlings from individual or group nurseries, some of which were established with support from the FSD.

Respondents' estimates of the amount of land planted with trees are presented in Table 3 and indicate that the average area planted since the time of entry amounts to 6.17 acres (2.47 ha) per farmer (n = 82). Virtually all respondents planted trees on their own land. Only one planted trees on the land of her spouse and one on land made available by the chief. None of the people in question were involved in sharecropping arrangements which are very common in Ghana (Amanor 2001). Remarkably, the average area planted by tree growers in Offinso FD is more than twice the average of farmers in the other forest districts, despite the fact that they could not count on continuous outside support from a company or NGO. This can be explained by their strong motivation to plant teak rather than perennial crops like cocoa, as the fire resistance of teak makes it a less risky investment in the dry deciduous environment that characterises Offinso FD.

Table 3: Average size of land planted per tree-planting respondent in acres (and ha)

Study village	Asankrangwa FD	Sefwi Wiawso FD	Offinso FD	Total
Sefwi Abrabra		4.25 (1.7)		
Sefwi Bopa		4.02 (1.61)		
Oda Kotoamso	5.27 (2.11)			
Akyekyere	4.99 (2.0)			
Nkenkaasu			13.3 (5.32)	
Nkwaankwaa			4.93 (1.97)	
Average size planted	5.16 (2.06)	4.12 (1.65)	10.64 (4.26)	6.17 (2.47)

NB: Figures in brackets is size in hectares (ha).

Information from Samartex (annual reports and personal communication with staff) indicates that, by November 2010, a total of 1,820 ha of off-reserve land in the Asankrangwa FD had been planted with economic timber trees. Of this total, 1,120 ha, involving 226 participants from 12 communities/villages in Samartex' operational area, were planted under specific agroforestry projects initiated by the company, such as the OCAP and the GTZ/Samartex PPP in Akyekyere. The other 700 ha were planted by about 700 individual farmers from 27 communities who had benefited from extension services provided by the Samartex project staff in collaboration with local staff of the FSD and the Ministry of Agriculture (MOFA).

In Sefwi Wiawso FD no records were available at the NGO or FSD on the total size of farmland planted with trees. However, records from the Ricerca e Cooperazione project office indicate that 466 farmers from 59 villages in this forest district had benefitted from the NGO's support for tree planting. Based on the average size planted with trees per farmer (1.65 ha) that came out of the survey, the total size of tree farms in Sefwi Wiawso FD can be estimated at 746 ha (466 x 1.65).

Records on the number of on-farm tree planters and area planted could not be obtained from the FSD office in Offinso FD either. According to an OTGA leader, who is well versed with people engaged in tree planting in the area, about 470 individuals from ten communities in Offinso FD are involved in this tree-growers association. Using the average size of 4.26 ha that respondents said they had planted with trees, we estimate the total size of tree farms in Offinso FD to be 2,002 ha (470 x 4.26).

4.3.4 Financial capital

Financial capital denotes the availability of cash or equivalent that enables people to adopt different livelihood strategies. It is the asset that tends to be the least available to the poor (DFID, 1999). Since it is difficult to collect accurate data on incomes in rural settings where farmers do not keep records, and because non-cash income is a large share of total income, the contribution of the on-farm tree planting scheme to peoples' cash and non-cash incomes was assessed in relative terms using Tool 4 of the Program on Forests (PROFOR)[7] 'Poverty-Forests Linkages Toolkit' (Shepherd and Blockhus 2008). In Asankrangwa and Sefwi Wiaswo FDs, where trees are generally inter-planted with cocoa or other perennials such as oil palm or orange, income from tree farms refers to food crops inter-planted with trees during the first years of agroforestry establishment (until canopy closure) and to income from the perennials once these start to produce (after 5 years for cocoa). In Offinso FD, where timber trees are planted in pure stands, data refers to the first three years until canopy closure when food crops can still be grown between the trees. In pure timber stands, food crops can no longer be cultivated once the canopy closes and will not generate income until the timber can be harvested.

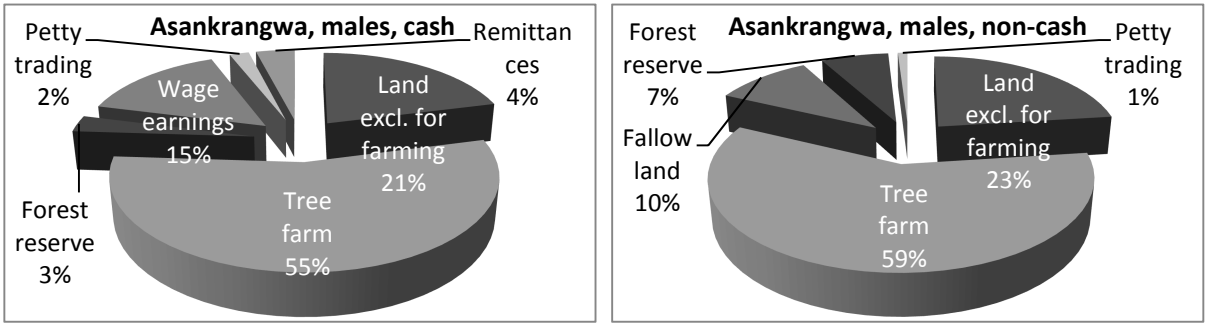

Figure 3a: Cash and non-cash income of male tree planting farmers in Asankrangwa FD

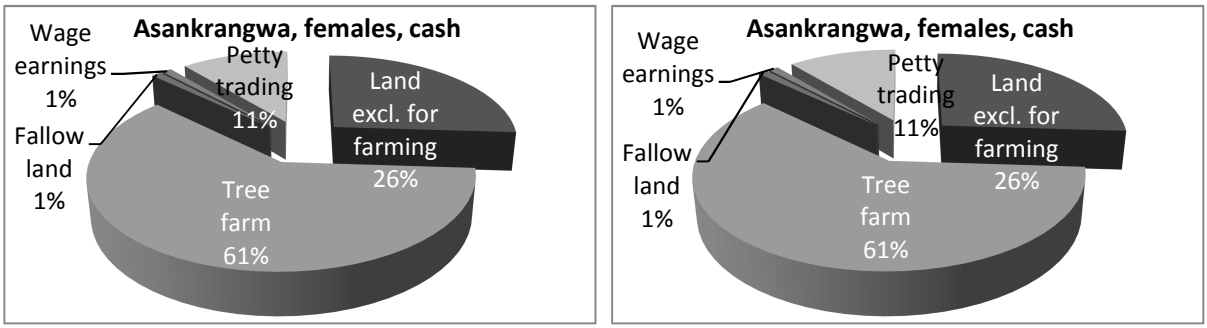

Figure 3b: Cash and non-cash income of female tree planting farmers in Asankrangwa FD

[7] PROFOR is a multi-donor partnership based at the World Bank that aims 'to support in-depth analysis, innovative processes and knowledge-sharing and dialogue' (www.profor.info).

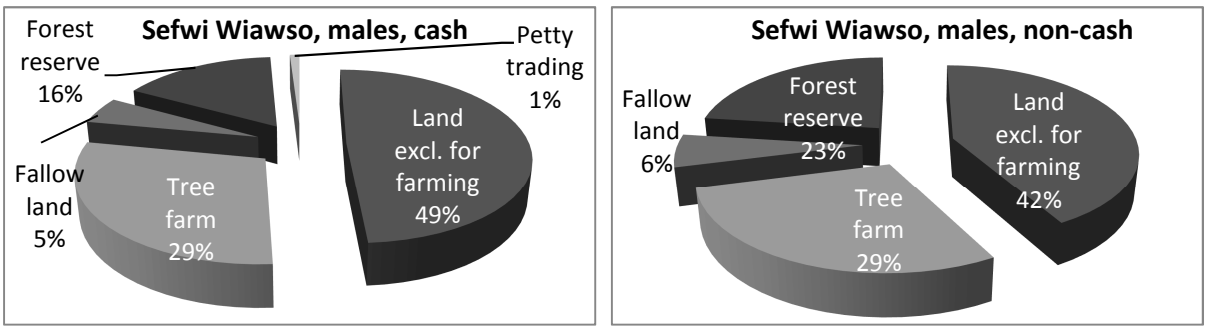

Figure 4a: Cash and non-cash income of male tree planting farmers in Sefwi Wiawso FD

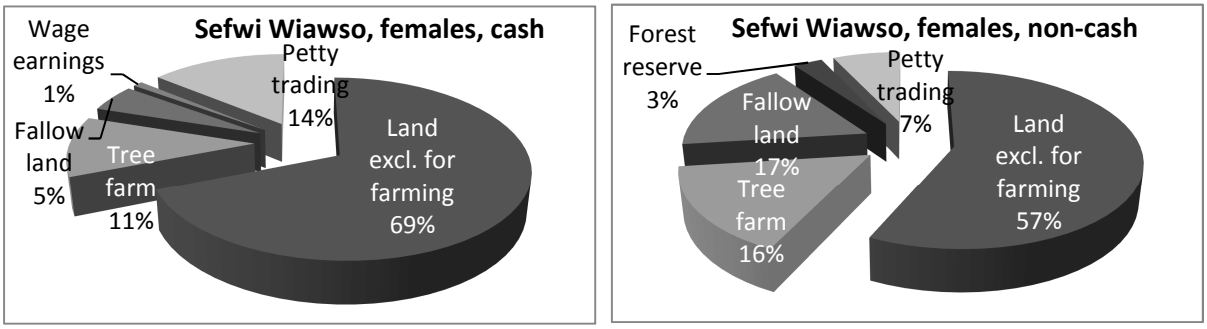

Figure 4b: Cash and non-cash income of female tree planting farmers in Sefwi Wiawso

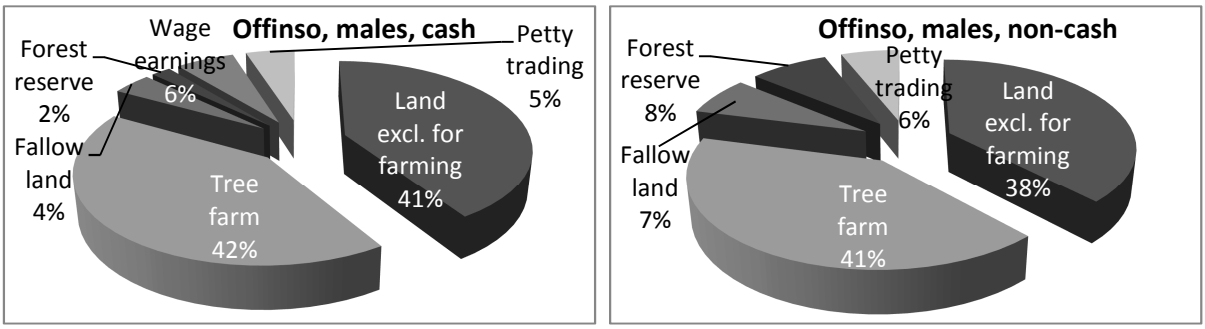

Figure 5a: Cash and non-cash income of male tree planting farmers in Offinso FD

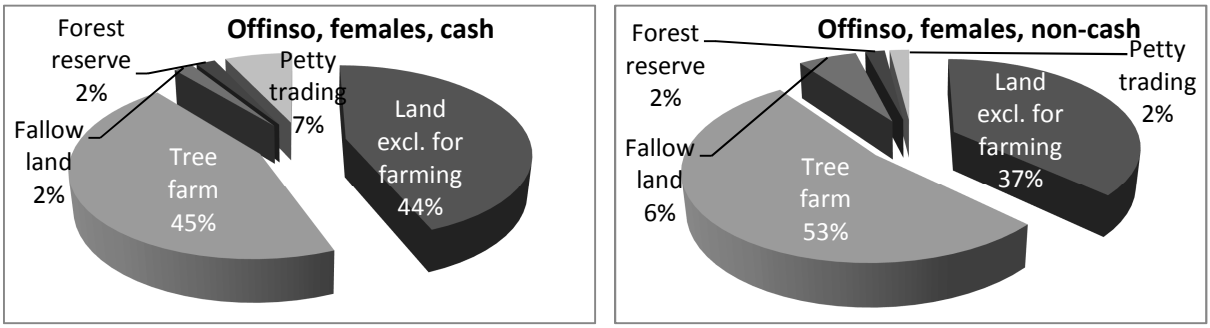

Figure 5b: Cash and non-cash income of female tree planting farmers in Offinso FD

The results as regards the proportional contribution of each activity to cash and non-cash incomes for the three study sites are presented in Figures 3-5, for men (a) and women (b) respectively. These results indicate that the participants derive their cash and non-cash incomes from land exclusively used for farming, tree farms, (off-reserve) fallow land and the forest reserve, and from wage earnings (mainly from day labour on other people's farms and plantations, locally referred to as 'by-day' and informal labour like masonry and carpentry), petty trading and remittances.

Agriculture, both from plots exclusively used for farming and tree farms, contributes the lion's share to people's cash and non-cash income (75-80% for men and 80-90% for women) across the three study forest districts. Income from tree farms is relatively more important to women than to men in Offinso FD, as it is based mainly on food crops, which are mainly the domain of female farmers. In the other study sites the trees are mainly integrated into cocoa farms, which are relatively more important to men.

As long as food crops can be harvested from them, the tree farms generate between 29% and 55% of cash income for males, and between 11% and 61% of cash income for females, with the relative contribution for both sexes being lowest in Sefwi Wiawso FD and highest in Asankrangwa FD. The contribution to non-cash income is between 29% and 59% for males and between 16% and 53% for females, with the lowest relative contribution noted in Sefwi Wiaswo FD and the highest in Offinso FD. Tree farms play a less important role as a source of cash and non-cash income in Sefwi Wiawso FD than in the other forest districts. This corresponds to the fact that tree planting is regarded as a low priority among farmers in this district (where cocoa is the priority crop) and has not been additionally stimulated since the departure of the NGO in 2004. Remarkably, the tree farm plots in this forest district are relatively less important for women's cash incomes (11%) than for those of men (29%), whereas the opposite is true for the relative contribution of land used exclusively for farming (which contributes 49% of the cash income of males and 69% of cash incomes of females). This difference, which is not evident in the other forest districts, can be attributed to the fact that men have continued to invest more than women in tree farms since the departure of the NGO.

In Asankrangwa FD, wage earnings contribute a larger share (15%) to men's cash income than in the other forest districts (nil in Sefwi Wiawso FD and 6% in Offinso FD). This can be explained by the employment created by the timber company that operates in this area. Wage earnings do not play a role in women's cash incomes, but they do engage more in petty trading instead, which contributes 7-11% to their cash incomes across the three study areas, as well as a modest share (ranging from 2-7%) to their non-cash incomes.

The forest reserve contributes a larger share to male cash (16%) and non-cash income (23%) in Sefwi Wiawso FD than in the other study sites, where the forest reserve contributes 3%/7% (Asankrangwa FD) and 4%/7% (Offinso FD) to the cash and non-cash incomes of males respectively. This can be explained by the fact that the villages in this study site are located closer to the forest reserve and that the reserve is relatively richer in biodiversity and therefore provides opportunities for hunting bushmeat and NTFP collection. The forest reserves hardly contribute to female income as women consider entering the reserve to be dangerous and the collection of NTFPs from the reserve to be physically demanding. Instead, they collect NTFPs from fallow lands, notably in Sefwi Wiawso FD, but also in Asankrangwa FD, where fallow lands contribute in particular to their non-cash income (13% and 17% respectively).

4.3.5 Physical capital

Physical capital comprises the basic infrastructure (e.g. roads, affordable transport, secure shelter and buildings, adequate water supply) and producer goods (e.g. tools) needed to support livelihoods (Scoones, 2009). In Asankrangwa FD, the timber company occasionally reconstructed the feeder road network leading to the tree farm plots under the agroforestry project. In Sefwi Wiawso FD, the NGO provided a number of water storage tanks in some of the communities, as a way of ensuring adequate and continuous water supply in the agroforestry plots. No such infrastructural support was available for tree growers in Offinso FD. Physical capital also took the form of houses which respondents had built with revenues from the tree farms. However, this was only possible for a minority, i.e. 10%, 7% and 15% of the respondents from Asankrangwa, Sefwi Wiawso and Offinso FDs respectively.

4.3.6 Respondents' perceptions of livelihood outcomes from on-farm tree planting

Respondents perceive on-farm tree planting as having both positive and negative effects on their livelihoods (Figure 6). Positive effects include employment creation, increased incomes, increased food production, enabling farmers to build houses and educating their children to higher levels, and positive environmental effects such as trees serving as wind breaks and stakes for crops and improved soil fertility. Negative effects include the high costs (which are perceived as draining money from the farmer), reduced crop yields due to shade effects, and an increased workload. An overview of cost categories involved in establishing tree farms is given in Appendix 1.[8]

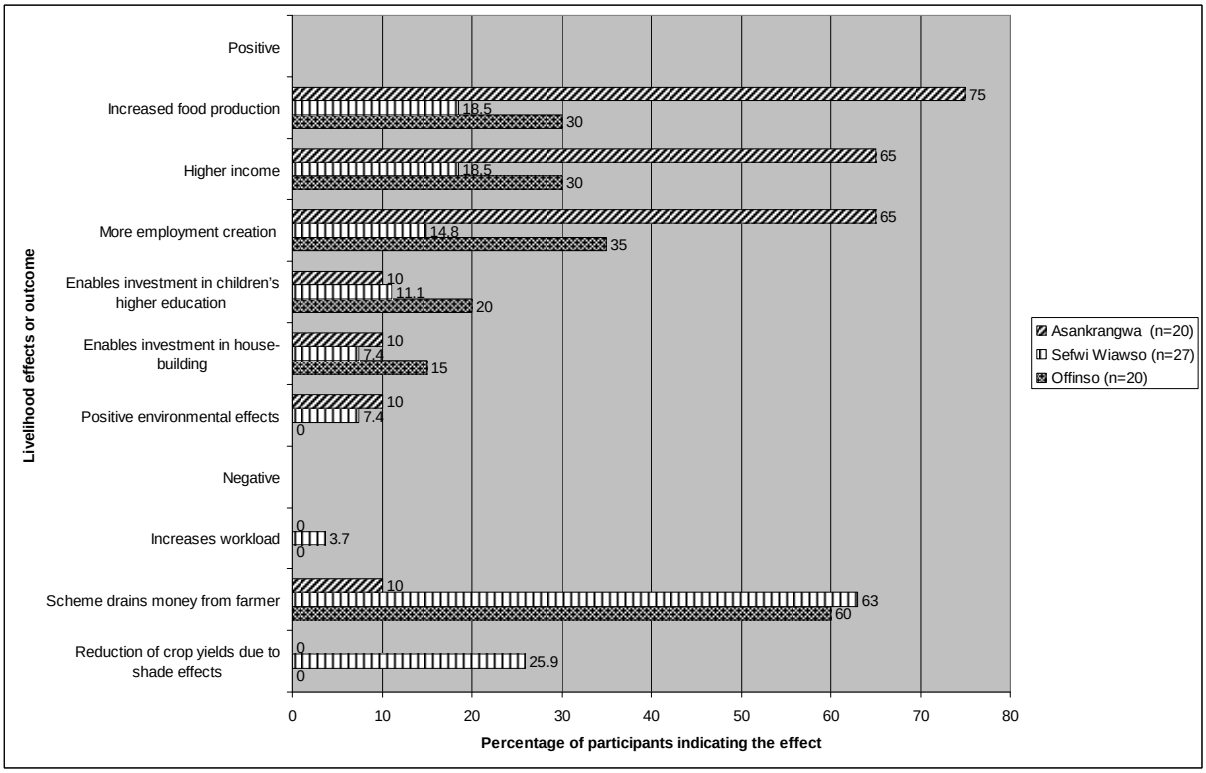

Figure 7: Respondents' perceptions of effects of on-farm tree planting on their livelihoods

[8] We considered the financial data that we collected on costs to be unreliable due to the failure by farmers to keep books and provide financial transparency, and therefore decided to provide an overview of items and labour time only.

Respondents from Asankrangwa FD supported by Samartex appear to be most satisfied with the scheme. Substantial numbers mentioned increased food production (75%), increased income (65%) and employment creation (65%) as positive effects, whereas only 10% mentioned a negative effect in the form of the scheme draining money from them. Only a minority of 10% indicated that they were able to accumulate assets in the form of investments in children's education or house building.

The NGO-supported tree planting scheme in Sefwi Wiawso FD generated the least positive perceptions of livelihood outcomes. Two of the three negative effects (increased workload and reduced crop yields due to shading) were only mentioned in this forest district (4% and 26% of respondents respectively), whereas no less than 63% stated that the scheme cost them money. Only a minority indicated positive effects, such as increased food production (19%), increased income (19%) and employment creation (15%), while even fewer tree growers indicated that they were able to accumulate assets in the form of investments in their children's education (11%) or house building (7%).

The perceptions of livelihood effects among respondents from Offinso FD indicate that about one third of them see positive effects in terms of increased food production (30%), increased income (30%) and employment creation (35%), whereas some were able to accumulate assets in the form of children's education (20%) and houses (10%). However, on the negative side, a majority (60%) indicated that the system drains them of money.

Only a few respondents from Asankrangwa and Sefwi Wiawso FDs (10% and 7% respectively) mentioned positive environmental effects, such as trees serving as windbreaks and stakes for crops like yam and black pepper, improving soil fertility and providing shade for cocoa trees.

Despite the fact that there are mixed feelings about current livelihood outcomes in two of the three forest districts, the majority (86%) of the respondents consider on-farm tree planting as a potentially important source of livelihood for the future, with the main reason being that it serves as a source of future income and creates a legacy for their children.

At the same time, the majority (80%) of respondents think that on-farm tree planting is not a reliable source of livelihood as there is still a lot of uncertainty about future income from trees (mentioned by 48%). They regard it as a safety net rather than a stable source of livelihood because they do not depend on it for their daily expenses (mentioned by 26%). Other reasons to be pessimistic about the stability of on-farm tree planting are based on perceived challenges, including (i) the lack of financial means for tree farm maintenance, especially after the third year when annual food crops can no longer be grown between the trees, (ii) high labour and/or maintenance costs, (iii) the time lapse between tree planting and harvesting with no immediate or regular benefits from trees in the meantime, and (iv) a lack of support and incentives for farmers from the government. Specifically in Sefwi Wiawso FD, where farmers plant timber trees in cocoa farms, there is a problem of shade effects of trees (notably cedrela) which result in reduced yields of intercrops. Field verification revealed that this was due to an excessively dense stocked spacing design. A problem mentioned only in Offinso FD – the only region where farmers were already harvesting teak – was the bureaucracy associated with obtaining harvesting rights and conveyance permits and uncertainty about prices for timber from off-reserve areas.

5. Discussion

Current rates of deforestation and forest degradation and the associated loss of goods and environmental services underline the need for new approaches to reforestation that address rural poverty (Lamb et al. 2005). Ghana implemented several of these approaches by launching its Forest Plantation Development Programme in 2001. Combined with laws which acknowledge farmers' rights to trees, this particularly encouraged smallholders with secure rights to their lands (Owubah et al. 2001) to use their land for tree farming.

The presence and encouragement of supporting organisations – public (the FSD) or private (timber company, NGO) – appeared to be decisive for the livelihood outcomes of tree-planting schemes. Even in the case of self-organisation in a tree grower's organisation, outside support in the form of occasional supply of tree seedlings and regular technical advice from the FSD was crucial. In terms of the relative importance of income from the tree farms (Figures 3-5) and farmer's perceptions (Figure 6) the timber company performed best. The explanation is related to the company's interest to make the scheme a success. Due to it having a stake in securing its source of raw material for the future, the company put all the necessary resources in place to ensure the success of the scheme. It established a separate agroforestry unit and contracted professional foresters to supervise the agroforestry programme and cooperated effectively with government agencies like the MOFA and FSD. Officers in the Samartex agroforestry project paid regular visits to the villages involved, ensuring that the right technical advice was given. By contrast the NGO had a broader scope with no specific interest or expertise in tree planting. Project officers were not necessarily professional foresters, nor did they have the financial means to visit the study villages on a regular basis. Furthermore they misjudged farmer's interest in tree planting in a region where cocoa and oil palm offer better perspectives. As far as government agencies are concerned, respondents attributed a lot of the challenges that they faced to the passive nature of state involvement and the lack of technical advice and incentives from the state.

Literature identifies secure land and tree tenure as another major factor in adopting on-farm tree planting, not only in Africa (e.g. Fortman 1985, Braselle et al. 2002), but also elsewhere (e.g. Dewees and Saxena 1997, Potter and Lee 1998). Moreover, in Ghana farmers with secure rights to land are more likely to plant trees on farmlands (Owubah et al. 2001). This is confirmed in this study, where virtually all respondents were owners of the land on which they planted trees, and none of the land where trees were planted was subject to a sharecropping arrangement. Samartex acknowledged the importance of secure tenure and deliberately facilitated the registration of land and tree rights for participating farmers in Asankrangwa FD.

On-farm tree planting has potential to become an important element of farm livelihoods (Dewees and Saxena 1997) by creating high value tree assets for the future. However, several challenges adversely affect participants' livelihoods and explain the mixed feelings among farmers about current livelihood outcomes. In the first place, it should be realised that on-farm timber tree planting is not based on farmers' traditional farming systems, which in Ghana's high forest zone is mainly reliant on a combination of food crop farming (with cassava, maize and plantain as the main crops) and cocoa farming (Chamberlin 2008). Tree planting has primarily been driven by a government interest in addressing timber deficits and rural poverty and has been implemented from above. Since colonial rule vested land ownership (and hence the right to a share in royalties from timber concessions) in customary authorities (the stool)

and postcolonial legislation (Act 1962 (124)) vested custody over trees in the state (Amanor, 2005; Boni 2006), trees have not played a role in farmers' livelihoods as no exploitation rights or benefit-sharing arrangements for farmers were in place. Against this background, it comes as no surprise that farmer's experience, skills, and knowledge of input, output and credit markets related to tree planting are limited (Chamberlin 2008). This partly explains why tree-planting schemes are extremely dependent on outside support.

Second, in view of limited benefits thus far, farmer's motivation for tree farm maintenance is restricted. Farmers in this study started tree planting mainly because of high expectations of future income (93%), with having wood for house building (19%) and creating a legacy for their children (18%) as secondary motivations. However, a combination of high costs for tree farm establishment and maintenance, the long gestation period of trees and the lack of funds for tree farm maintenance once food cropping between the trees is no longer possible, has discouraged farmers and hampered the continuity and success of the scheme. The lack of income between canopy closure and timber harvesting is a problem in most reforestation schemes that focus on trees in pure stands (Boni 2006).

Third, the few farmers (in Offinso FD) who engaged in tree farming long enough to harvest some trees faced several bureaucratic hurdles. Procedures for obtaining harvesting and conveyance permits were lengthy, leading to low prices being paid by timber companies.

Among the options suggested in literature to address the financial challenges of tree planting schemes is the advanced or gradual purchase of timber from farmers (Boni 2006; Montagnini et al. 2005). More concretely, Boni (2006: 6) suggests to facilitate the institution of a timber 'co-ownership agreement policy', which allows the timber company (buyer) to purchase timber gradually by paying a small yearly maintenance support fee (e.g. 30-50 dollar cents per tree per year) to the farmer (planter). In exchange for the yearly maintenance fee, the buyer acquires joint ownership of the timber and the right to purchase the remaining half at harvest at the prevailing market price. Alternatively, the maintenance fee can be considered a loan scheme to the farmer, to be paid at harvest with interest. If such a scheme is considered, it is important to put an insurance system in place in order to deal with the risks of drought, fire and timber theft.

Another option is to link on-farm tree planting to climate change mitigation programmes and carbon schemes under the Clean Development Mechanism (CDM) or non-Kyoto compliant voluntary carbon sequestration projects (Jindal et al. 2008). The Kyoto Protocol recognises carbon sequestration through forestry as a way of mitigating global warming (Jindal et al. 2008). Forestry is allowed under the CDM in the form of tree planting or reforestation, with special attention given to small-scale reforestation projects under Article 12 (Decision 19/CP.9) of the Kyoto Protocol, which is meant to assure that low-income communities also benefit from CDM projects (Boyd et al. 2007). Although the tendency is to be optimistic about the potential that carbon markets offer to agroforestry and smallholders (see e.g. Scherr et al. 2004; Montagnini and Nair 2004), several authors have also noted the hindrances related to smallholder's participation in carbon markets, such as the regulatory burden and high transaction costs (Smith and Scherr 2003). In Ghana, the inclusion of smallholders in carbon trade occurs on a pilot scale only and was not identified in the study villages. Considering the importance of generating income from tree farms for the farmers, supporting institutions need to proactively facilitate such carbon projects, as Samartex has done in Asankrangwa FD by facilitating research on assessing carbon contents of planted trees.

Considering the challenges identified in Ghana's on-farm tree planting scheme, there is a need for a partnership approach (Ros-Tonen 2007) based on cooperation between a wide range of stakeholders. In our view, co-management is not necessarily limited to state and community actors, but may also involve a company-community partnership or NGO-community partnership as described in this paper. Public actor involvement in such partnerships is crucial for the success of tree planting and agroforestry schemes. Firstly, the public sector can create an enabling environment by providing agroforestry extension, by improving road networks and means of transportation that enable efficient marketing of products from the system, and by facilitating agroforestry research and the dissemination of its results. Secondly, joint and coordinated action by the FC/FSD and the Ministry of Agriculture may help develop the on-farm tree planting scheme into a multi-purpose agroforestry system from which cash and non-cash incomes can be derived on a more continuous basis than currently is the case. Thirdly, despite efforts to promote co-management between the FC and rural communities, hierarchical governance still prevails in Ghana (Ros-Tonen et al., 2010), as a result of which farmers take a wait-and-see attitude and a dependent stance towards government agencies.

In our view, the kind of agroforestry scheme that is most appropriate for Ghana's high forest zone, especially on fertile lands, is the integration of economic timber trees with permanent agricultural crops such as cocoa, cola and oil palm, with initial integration of food crops. In this case the adoption of an appropriate tree-crop mix spacing is important to ensure reduction of shade effects, especially on adjacent agricultural crops. Such an agroforestry system has potential for effective livelihood improvements since farmers can benefit from short-term income from food crops, medium-term income from permanent agricultural crops (that have an early maturity period ranging from 3-5 years) and long-term income from both the trees and permanent agricultural crops. On marginal lands that are less suitable for permanent agricultural crops, the establishment of woodlots for charcoal and firewood, using species like *Senna siamea*, would be helpful in ensuring a regular provision of incomes to the farmers involved.

It is fair to question whether the introduction of tree planting from above is feasible at all. Tree planting is a relatively new venture for smallholders in Ghana. Integrating tree planting into their farming system therefore requires an adaptive approach to co-management, with mechanisms in place that ensure feedback, joint learning and building of mutual support among the partners (Berkes 2004). Folke *et al.* (2002: 20) define adaptive co-management as 'a process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, ongoing, self-organized process of learning-by-doing'. Adaptive management and co-management need to co-evolve because adaptive management without collaboration lacks legitimacy, and co-management without learning-by-doing does not develop the ability to address emerging problems (Derkyi et al., forthcoming). Maturing co-management arrangements become adaptive co-management in time, through successive rounds of learning-by-doing (Armitage *et al*., 2007; Olsson *et al.*, 2004). In essence, one of the ways of ensuring high productivity and sustainable management of long-term projects like on-farm tree planting, whether under external or self-organised support, is to adopt an attitude of learning from feedback and the experiences of others.

7. Conclusions

This paper reviewed the livelihood outcomes of on-farm tree planting in three forest districts in Ghana's high forest zone. It showed that the scheme contributes substantially to cash and non-cash income based on food crops, but that these livelihood benefits are mostly limited to

the first three years of tree farm establishment, unless trees are inter-planted with perennials such as cocoa. Four issues came to the fore as conditions for ensuring adoption and continuous farmer involvement in the scheme.

First, considering the lack of experience and skills in tree planting among smallholders, continuous professional support is crucial for the time being, be it in the form of technical advice, seedlings supply, or training in nursery establishment and tree planting skills. This support can come either from the state, private sector or the leadership of a tree growers association, preferably in a partnership approach.

The importance of secure land tenure and tree harvesting rights (including reducing the bureaucratic requirements of obtaining harvesting and conveyance permits) emerged as a second important condition for farmers' successful engagement in tree planting. Such rights need to be ensured and the playing field has to be levelled in order for farmers to capitalise on planted trees. Further research is needed to assess how farm size and tenure arrangements affect the adoption and continued engagement in tree planting, in order to obtain more insight into the question of whether tree planting is feasible for poorer farmers – usually migrants – who are engaged in sharecropping arrangements or who have small plots where the planting of trees may compete with food crops.

Third, we identified numerous uncertainties as regards future benefits from tree planting. Together with the lack of experience in tree farming, this highlights the need for an adaptive management approach in order to deal with these uncertainties.

Finally, income sources need to be found to deal with the time lapse between investment and returns from timber trees. This requires further research into (i) possibilities to turn on-farm tree planting into a full agroforestry system that provides non-timber forest products and proceeds from shade-tolerant crops throughout the rotation period, (ii) possibilities for farmers to obtain timber benefits before the trees are actually harvested through thinning or gradual purchase or advance payments that compensate them for tree maintenance, and (iii) possibilities to link tree planting to carbon and other payments for environmental services (PES) schemes.

For sustainable benefits from on-farm tree planting, both in terms of livelihoods and carbon sequestration, it is of utmost importance that on-farm tree planting develops into an agroforestry system from which multiple benefits – including carbon credits – can be obtained to bridge the period between tree farm establishment and timber harvesting. Otherwise there is the risk that the carbon sequestered will leak away due to farmers encroaching on the forest in search of additional farmland.

Acknowledgements

The authors would like to thank Tropenbos International (TBI) for funding and TBI-Ghana for general, capacity building and logistical support. Thanks are also due to the respondents who willingly devoted time to participate in surveys and interviews. We also appreciated the useful comments made by an anonymous referee to an earlier draft of this paper.

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Appendix 1: Activities involved in on-farm tree planting (planting and maintenance costs)

Scenario 1[a]		Scenario 2[b]	
Activity	**Input/ Quantity / Schedule**	**Activity**	**Inputs / Quantity / Schedule**
1. Land preparation		1. Land preparation	
- Clearing	Labour (20 md)	- Clearing	Labour (20 md)
- Stumping/debris removal	Labour (20 md)	- Stumping/debris removal	Labour (20 md)
2. Planting		2. Planting	
(i) Maize	15 kg seeds + labour (15md)	(i) Maize	15 kg seeds + labour (15 md)
(ii) Cedrela / Teak	1,111 seedlings[c] + labour (10 md)	(ii) Mahogany / Ofram	67 seedlings[d] + labour (1 md)
(iii) Cocayam	900 corms + labour (13 md)	(iii) Cocayam	1000 corms + labour (17 md)
(iv) Yam	200 setts + stakes+ labour (8 md)	(iv) Plantain (3 m x 3 m)	1,111 suckers + labour (25 md)
(iv) Plantain	1,111 suckers + labour (25 md)	(v) Cassava	2 ½ head-loads + labour (4 md)
(v) Cassava	2 ½ head-loads + labour (4 md)	(vi) Vegetables (pepper, etc.)	250 seedlings + labour (4 md)
(vi) Vegetables (pepper, etc.)	250 Seedlings + labour (4 md)	(vii) Cocoa (at 3 m x 3 m)	1,111 seedlings + labour (15 md)
3. Maintenance		3. Maintenance	
(i) Weeding - labour (3 times each in 1st to 3rd yr)	90 md each in 1st to 3rd yr	(i) Weeding - labour (3 times each in 1st to 3rd yr)	90 md each in 1st to 3rd yr
(ii) Filling in[e]	120 seedlings + labour (2 md)	(iii) Filling in timber	20 seedlings + labour (1 md)
(iv) Pruning	Labour (5 md) each in 3rd yr	(iv) Filling in cocoa	200 seedlings + labour (4 md)
		(v) Cocoa spraying[f] (2 times per yr at 2 litres, start at 2nd yr)	chemical + labour (10 md)
		(vi) Cocoa - fert. application	2 bags fert + labour (2 md)
		(vi) Pruning of cocoa	Labour (2 md)
		(vii) Pruning of timber trees	Labour (1 md each in 3rd yr)
4. Harvesting		4. Harvesting	
(i) Maize	Labour (12 md in 1st yr)	(i) Maize	Labour (12 md in 1st yr)
(ii) Vegetables (pepper, etc)	Labour (4 md each in 1st & 2nd yr)	(ii) Vegetables (pepper, etc.)	Labour (4 md each in 1st - 4th yr)
(iii) Cocoyam	Labour (8 and 6 md each in 2nd & 3rd yr)	(iii) Cocoyam	Labour (8 and 6 md each in 2nd-4th yr)
(iv) Yam	Labour (2 md in 2nd year)	(iv) Yam	Labour (2 md in 2nd year)
(v) Cassava	Labour (5 md each in 2nd & 3rd yr)	(v) Cassava	Labour (5 md each in 2nd &3rd yr)
(vi) Plantain (2/3 of planted)	Labour (4 md each in 2nd &3rd yr)	(vi) Plantain (2/3 of planted)	Labour (4 md each in 2nd& 3rd yr)

Key: md = man days; yr = year

[a] Based on exotic timber species planted at 3 m x 3 m, with initial stocking of 1,111 seedlings/ha and referring to the first 3 years of establishment (2002 to 2004).

[b] Based on indigenous timber species inter-planted with cocoa at a spacing of 10 m x 15 m, with initial stocking of 67 seedlings/ha and referring to the first 3 years (2002 to 2004).

[c] Spacing of 3 m x 3 m = 9 m^2.

[d] Spacing at 10 m x 15 m = 150 m^2

[e] Filling in means planting timber trees in open spaces that are due to trees that failed to survive (in forestry referred to as 'beating up').

[f] Cocoa spraying is done free by the government; but farmer supplements the spraying.

Source: Based on in-depth interviews with six smallholders from the three forest districts.