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SEEING THE TREES FOR THE CARBON: AGROFORESTRY FOR DEVELOPMENT AND CARBON MITIGATION

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Abstract

Land-use, land-use change and forestry (LULUCF) activities will play an important role in global climate change mitigation. Many carbon schemes require the delivery of both climate and rural development benefits by mitigation activities conducted in developing countries. Agroforestry is a LULUCF activity that is gaining attention because of its potential to deliver climate benefits as well as rural development benefits to smallholders. There is hope that agroforestry can deliver co-benefits for climate and development; however experience with early projects suggests co-benefits are difficult to achieve in practice. We review the literature on agroforestry, participatory rural development, tree-based carbon projects and co-benefit carbon projects to look at how recommended project characteristics align when trying to generate different types of benefits. We conclude that there is considerable tension inherent in designing co-benefit smallholder agroforestry projects. We suggest that designing projects to seek ancillary benefits rather than co-benefits may help to reduce this tension.

Keywords: co-benefits, climate change mitigation, rural development, agroforestry, smallholders

1. Introduction

Land-use, land-use change and forestry (LULUCF) are important contributors to global climate change. The Intergovernmental Panel on Climate Change (IPCC) estimates that land-use change contributed one third of global carbon emissions from 1850-1998 (Watson et al. 2000). LULUCF, particularly deforestation for cropland, remains important: seventeen million hectares are deforested annually, with tropical deforestation contributing 25% of CO_2 and up to 10% of N_2O emissions globally (Montagnini and Nair 2004; Palm et al. 2004). Despite this contribution to global emissions, interest in mitigation through LULUCF mitigation activities (e.g. carbon credits from forestry) was initially limited due to issues with permanence, leakage, and accounting methods (Hamilton et al. 2010; Kossoy and Ambrosi 2010; Milne 1999).

Today, some of those challenges have been addressed, more opportunities exist and the use of LULUCF activities is rising. Traded volumes have increased steadily since 2007 when the volume of forest carbon credits traded jumped 228% over the previous year (Hamilton et al. 2010; Kossoy and Ambrosi 2010). Most credits are generated through projects involving tree planting (77% in 2008) and are traded on the voluntary market (95% in 2008) (Hamilton et al. 2010).

At the same time, understanding is growing that global climate change mitigation goals should be pursued concurrently with sustainable development (e.g. Council of the European Union 2009;

UNFCCC 2009). Thus, many mitigation schemes require that projects contribute to sustainable development in the host country.

Agroforestry is gaining attention for use in LULUCF mitigation activities in developing countries because of its potential to mitigate climate change and because of its links to agriculture and forestry, activities central to the livelihoods of many of the world's poorest people. It is hoped that agroforestry could simultaneously help to address climate and development goals by generating "co-benefits" (Garrity 2004; May et al. 2005; Nair et al. 2009; Pandey 2007; Roshetko et al. 2007; Schroeder 1994; Watson et al. 2000).

1.1 Agroforestry: Potential Rural Livelihood and Climate Change Mitigation Benefits

Agroforestry is a land-use that purposefully combines tree-growing and conventional agricultural practices on the same land management units to generate social, economic and environmental benefits and services (FAO 2010; ICRAF 2010; Nair 1993; Nair et al. 2009). Because agroforestry can provide livelihood benefits (both monetary and non-monetary) when the right practices are used (Table 1), it has been promoted in development programs to benefit poor rural households, mainly subsistence farmers on small landholdings (Nair et al. 2009). Most development agroforestry literature takes an implied participatory development approach, which values broad engagement of farmers in the development process and methods that facilitate participation (Campbell and Vainio-Mattila 2003; Hayward et al. 2004; Mohan 2007; Williams 2004). About 1.2 billion people in developing countries rely on agroforestry (Watson et al. 2000), and use is expected to increase to meet the resource needs of rapidly growing populations (Oelbermann et al. 2004).

Recently, interest in also using agroforestry for climate change mitigation has grown based on its potential to deliver benefits from carbon sequestration and reduced emissions (Table 1). The IPCC estimates that 250 Mha of deforested land in the humid tropics could be converted to agroforestry at a rate of 3% per year, with an average potential sequestration rate of 3.1 t C $ha^{-1}yr^{-1}$, the highest of any LULUCF activity described by the IPCC apart from restoration of forestland (Watson et al. 2000).[1]

[1] Nair et al. (2009) suggest that estimates of sequestration potential for agroforestry should be used with caution. This figure is included to indicate the hoped-for contribution of agroforestry to mitigation relative to other activities, a motivation for increased interest in its use.

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Table 1: Potential benefits of agroforestry adoption for development and climate

	Benefits	**References**[a]
Development	Tree products for household use and sale • Fuel • Food • Building materials and other wood products	4,7,8,13,20,24-5
	Income & employment • Reduced poverty • Income security • Income diversification	3-5,10,12-3,19, 20,22,24
	Secondary livelihood benefits • Resilience • Dignity • Health & nutrition	5,9,12,22-3
	Local environment improvement • Restoration and improvement of soil • Reduced soil erosion • Conservation and improvement of water resources • Increased biodiversity over monocrop systems • Animal habitat and wildlife corridors • Reduced use of unsustainable land-use practices	1, 4-6, 8,15,20,24-5
	Livelihood benefits from environment improvement • Increased crop production and food security • Improved water use efficiency • Support of biological pest control	1,6,8,10,12,20, 22-5

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	Benefits	References[a]
Climate	Carbon sequestration potential greater than crop or pasture systems[b] • Biomass – above and below ground • Soil • Wood products	1,6,11,13,14,16-7,18-22,24-5
	Lower GHG emissions compared to cropping systems • N_2O emissions similar to natural forests • CH_4 sinks	14,19,24-5
	Avoided emissions • Substitution of fossil fuels and fossil fuel-intensive materials[c] • Alternative sources of tree products → avoided deforestation and forest degradation[d] • Alternative to higher-emission land-uses	1,2,5,6,13,15-6,19,20,24-5

[a]1.Albrecht and Kandji 2003; 2.Appiah et al. 2009; 3.Bognetteau et al. 2007; 4.Current and Scherr 1995; 5.Current et al. 1995; 6.Dixon 1995; 7.Dixon et al. 1994; 8.Fischer and Vasseur 2002; 9.Garrity 2004; 10.Jama et al. 2006; 11.Lal 2004b; 12.Leakey et al. 2005; 13.Montagnini and Nair 2004; 14.Mutuo et al. 2005; 15.Nair 2007; 16.Nair et al. 2009; 17.Niles et al. 2002;18.Oelbermann et al. 2004; 19.Palm et al. 2004; 20.Pandey 2007; 21.Roshetko et al. 2007; 22.Sanchez 2000; 23.Sanchez 1999; 24.Schroeder 1994; 25.Watson et al. 2000

[b]Agroforestry systems can regain 35% of the carbon stock and store soil carbon at a rate of 80-100% that of forest, compared to 12% and 50% respectively on crop or pastureland (Palm et al. 2004; Watson et al. 2000).However, systems vary considerably and sequestration potential depends on practices used (Albrecht and Kandji 2003; Current et al. 1995; Mutuo et al. 2005).

[c]The IPCC estimates that substitution of renewable biomass for fossil fuels could avoid about 3.5 Gt carbon/yr, more than half of current fossil fuel emissions (Watson et al. 2000).

[d]Difficulty estimating the area under agroforestry makes it hard to determine the exact impact of agroforestry adoption on deforestation (Montagnini and Nair 2004; Nair et al. 2009).

1.2 Climate-Development Co-Benefits from Agroforestry?

Use of the term “co-benefits” usually signals that two or more outcomes or goals are desired from a single project, often with a goal of maximization of benefits.[2] Many believe that carbon agroforestry

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[2] In the carbon literature, the term “co-benefits” is commonly left undefined, or used interchangeably with “ancillary benefits” (e.g. Aunan et al. 2004; Pittel and Rübbelke 2008). For the purposes of this discussion, a “co-benefit project” is addressing and maximizing benefits for dual development and climate priorities.

is a tool with significant unrealized potential, particularly for delivering benefits from carbon schemes to smallholders (Montagnini and Nair 2004; Nair et al. 2009; Oelbermann et al. 2004; Roshetko et al. 2007). Estimated to be worth $16.8 billion over 10 years to tropical and developing countries (Niles et al. 2002), the potential impact of carbon finance is significant.

However, seeking co-benefits in individual projects may be complicated in practice. The United Nations Food and Agriculture Organization has warned that poor land users will not automatically benefit from carbon payments (Boyd et al. 2007). Not all agroforestry systems will deliver all or any of the benefits described. The adoption of certain systems can be costly from a development or carbon perspective: for example, some systems may be significant sources of GHG emissions (Dixon 1995), and some can have negative effects on crop production (Reynolds et al. 2007; Siriri et al. 2009). Modeling suggests that best practices for realizing carbon benefits may not always be best for realizing livelihood benefits (van Noordwijk et al. 2008), and potential trade-offs have been identified in forest management between global environmental services like carbon and services that are important for local people (Locatelli et al. 2011). Several authors have concluded that many early carbon projects, particularly compliance market projects, have been largely unsuccessful in delivering co-benefits, with development goals being met only in a limited way or not at all (Bailis 2006; Boyd et al. 2007; Brown and Corbera 2003; Cosbey et al. 2005; Milne and Arroyo 2003; Lövbrand et al. 2009; Murdiyarso et al. 2008; Nelson and de Jong 2003; Nishiki 2007; Olsen 2007; Sutter and Parreño 2007; Wittman and Caron 2009).

The purpose of this paper is to systematically explore the implications of seeking co-benefits in carbon agroforestry programs. In reviewing common practices and project design recommendations in the literature, we use qualitative coding to analyze how and whether agroforestry projects might generate co-benefits towards addressing the dual challenges of mitigating climate change and enhancing livelihood opportunities in developing countries. We conclude with implications for effective project design and call for change in the way that co-benefits are approached to minimize tensions and maximize synergies.

2. Methods

Co-benefits will be difficult to realize in practice if maximizing desired outcomes for development and carbon requires significantly different project designs. When implementing carbon-development co-benefit projects, practices best suited for realizing and maximizing one goal may or may not be the same as or compatible with best practices for realizing and maximizing the other. For a given project design characteristic, there are several possibilities when comparing recommended or widely adopted practices for realizing each desired goal:

Likely Tension – Best practices for a given project characteristic conflict.

Possible Tension – Best practices for a given project characteristic may be in conflict, either because the characteristic is specified for one type of benefit but not the other, or because significant variation of this characteristic is possible depending on project context.

Alignment – Best practices for a given project characteristic to realize and maximize one goal are not expected to interfere with practices to realize and maximize the other.

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Synergy – Best practices for a given project characteristic compliment those for the other, such that greater benefits may be realized than when each goal is sought separately.

We reviewed academic and grey literature on smallholder agroforestry for rural development, tree-based carbon projects, and carbon co-benefit projects to examine how well best practices align when agroforestry is attempted for co-benefits for carbon and development. Using qualitative inductive coding methods (Bernard 2006), we identified recommended and common practices for realizing development and carbon benefits described in the publications. We then grouped these practices according by project characteristic. The project characteristics varied widely and were related to different aspects of project design and implementation. To help understand how project characteristics related to each other, the project characteristics were clustered into three broad categories:

Enabling Conditions

Pre-existing political, social, economic and environmental site conditions that operate at various scales and facilitate the realization of a successful project (e.g. the availability of resources such as land and information.

Substantive Project Characteristics

The who, what, when, where and how of the project: who is participating and how, project duration and size, what end product(s)are desired, and the planned methods for directly achieving them.

Process Project Characteristics

Elements of project design and implementation that facilitate project success but do not directly contribute to project goals, including characteristics that shape the participation of local people and how the project interacts with factors outside the project.

Finally, practices for realizing development versus carbon goals were compared for each project characteristic within each cluster and then classified according to whether they could be expected to be sources of Likely Tension, Possible Tension, Alignment, or Synergy as defined above.

3. Results: Identifying Synergies and Tensions When Attempting Co-Benefits

A summary of results is presented in Table 2. Carbon finance is a key source of potential synergy. It can provide opportunities to diversify and leverage additional funding for agroforestry (Palm et al. 2004; Roshetko et al. 2007), as well as opportunities to overcome barriers to agroforestry uptake (Harris 2007; Palm et al. 2004). Even small carbon returns could provide additional income and added incentives for the adoption of tree-based systems by farmers (Cacho et al. 2004), and important early revenue for project developers (Van Vliet et al. 2003). However, it may be difficult to take advantage of these opportunities because a number of project characteristics are likely in tension. Section 3.1 discusses possible tension and synergy relating to the nature and timing of project goals and outcomes in co-benefit projects. Section 3.2 discusses likely tension between practices that facilitate community participation versus those that keep project costs down. A more

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detailed discussion of expected tension and synergy for all project characteristics can be found in the Electronic Supplemental Materials.

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Table 2: Predicted tensions and synergies in project characteristics when agroforestry is attempted for co-benefits for climate and development[a]

Project Characteristics		**Development**	**Carbon**	**Tensions and Synergies in Realizing Co-Benefits**
Enabling Conditions		Supportive government, policy and socioeconomic environments; emphasis on secure land and tree tenure and sufficient resources to support land-use change	Supportive government, policy and socioeconomic environments; emphasis on secure land and tree tenure and sufficient resources to support land-use change	**Alignment**
Substantive Project Characteristics	**Participants and Partnerships:**	Social NGOs, Multi-stakeholder partnerships	Technical NGOs	**Likely Tension:** Contract length and flexibility; Project and farm size; Transaction costs; Provision of on-going education, training and technical support **Possible Tension:** Participants and partnerships; Project length; Timing of payments; Monitoring; Fund allocation; Agroforestry practices; End products **Alignment:** Monitoring; Agroforestry practices **Synergy:** Time to returns; Carbon finance; Agroforestry practices; End products
	Project Timeline:	Longer term projects; Shorter term or flexible contracts; Short-term returns to farmers	Longer-term projects; Longer, rigid contract terms to meet certification requirements; Short-term returns to investors and payment upon delivery of services	
	Project Size:	Small scale, small farm size	Large scale, large farm size	

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Project Characteristics		Development	Carbon	Tensions and Synergies in Realizing Co-Benefits
Substantive Project Characteristics (cont.)	**Project Economics:**	Mainly donor funds; Farmers need access to upfront financial incentives or markets; High costs in smallholder projects; Involve community to lower monitoring costs	Carbon finance available; High transaction costs associated with generating carbon credits; Expensive monitoring - involve community to lower costs	
	Agroforestry Practices:	Mixed species, context-matched agroforestry practices	High carbon systems	
	End Product(s):	Tangible products for household use or local and regional sale	Less tangible carbon credits for sale on primarily on international markets	
	Monitoring:	Involve community to lower costs	Extensive monitoring to ensure credit validity	
	Education, Training and Technical Support:	Capacity-building emphasized	Minimized except where reduces transaction costs	

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Project Characteristics		**Development**	**Carbon**	**Tensions and Synergies in Realizing Co-Benefits**
Process Project Characteristics	**Preliminary Site Assessments:**	Important for site suitability and adaptation to local conditions	Not emphasized	**Likely Tension:** Flexibility of project design and implementation; Community participation; Facilitating market access **Possible Tension:** Preliminary site assessments; Interaction with project context and integrating with other activities; Demonstration of benefits **Alignment:** Community participation that reduces transaction costs **Synergy:** Integrating with other development activities to diversify funding
	Interaction with Project Context/Integration with Other Activities:	Extensive, active	Less common	
	Flexibility of Project Design & Implementation:	Contracts non-existent or flexible, adaptive programming	Standardized and rigid project designs and contracts	
	Community Participation:	Involvement in all stages recommended; Participatory, bottom-up decision-making.	Minimized, except where can reduce transaction costs; Top-down decision-making.	

Project Characteristics		**Development**	**Carbon**	**Tensions and Synergies in Realizing Co-Benefits**
Process Project Characteristics (cont.)	**Demonstration of Benefits**	Emphasized, through demo farms	Not included	
	Market Availability and Access	Not needed where end products are for home consumption; Direct access to local markets by local farmers or farm organizations	Access to global markets through intermediaries and brokers	

[a]Sources: Albrecht and Kandji 2003; Appiah et al. 2009; Ashley and Carney 1999; Bognetteau et al. 2007; Boyd et al. 2007; Brown et al. 2000; Bull et al. 2008; Chivinge 2006; Current and Scherr 1995; Dixon 1995; Dixon et al. 1994; Dolan 2006; Fischer and Vasseur 2000, 2002; Garrity 2004; Harris 2007; Jama et al. 2006; Lal 2004[a], 2004b; Leakey et al. 2005; Macqueen 2009; Makundi and Okiting'ati 1995; Milne and Arroyo 2003; Montagnini and Nair 2004; Mutuo et al. 2005; Nair et al. 2009; Nelson and de Jong 2003; Niles et al. 2002; Noble and Dirzo 1997; Oelbermann et al. 2004; Palm et al. 2004; Pandey 2007; Roshetko et al. 2007; Rudebjer et al. 2006; Sathaye et al. 2001; Schroeder 1994; Seeberg-Elverfeldt et al. 2009; Shiferaw et al. 2009; Watson et al. 2000

3.1 Nature and Timing of Project Goals and Outcomes

Development projects tend to have a more social focus and target primarily local beneficiaries, while carbon projects tend to have a more commercial focus, usually targeting international markets. Attempting co-benefits means that an agroforestry project has two goals that differ significantly in terms of their primary orientation and scale of impact, and the nature and timing of possible end products (Table 3). These Substantive Project characteristics could be important sources of tension.

Table 3: Nature and timing of products from development and carbon agroforestry projects

	Development	**Carbon**
Tree products	Variable, tangible goods Variable time to returns	Less tangible carbon credits Limited tangible goods Longer returns from tangible goods Earlier returns from credits
Agricultural products	Varied, early returns	Limited, early returns

End Products and Agroforestry Practices: Desired development benefits and the agroforestry practices to generate them vary based on local conditions, needs and desires (Boyd et al. 2007; Dixon et al. 1994; Roshetko et al. 2007), and may not align with practices that improve carbon storage and reduce emissions. For example, high quality organic inputs maximize crop yields while lower quality inputs reduce emissions (Mutuo et al. 2005).

Contracts: Longer-term, standardized contracts, used in carbon projects to guarantee carbon benefits and reduce costs (Gong et al. 2010), can limit what products can be generated, delay time to returns from non-carbon products, and reduce flexibility (Anderson and Zerriffi Unpublished Working Paper; Roshetko et al. 2007). This has been a source of tension in smallholder planting initiatives in China, Ecuador and Uganda (Anderson and Zerriffi Unpublished Working Paper; Gong et al. 2010; Milne and Arroyo 2003).

Time to returns: Trees take longer to deliver returns compared to conventional agricultural crops. Most smallholders do not have sufficient reserves to sustain a large initial reduction in returns, even if their long-term gain would be greater (Shiferaw et al. 2009). For development benefits from tree planting, farmers need access to short term returns, financial incentives or credit (Fischer and Vasseur 2002; Gong et al. 2010; Torres et al. 2010). In carbon markets, payment upon delivery of credits is often preferred because it reduces risk to project developers and increases assurance of permanence (Harris 2007; Kossoy and Ambrosi 2010). If farmers are substituting trees for crops, delaying returns to farmers could cause tension, especially if this acts as a disincentive to participation by making alternative land-uses that can provide earlier payments more attractive (Gong et al. 2010).

Synergistic effects from carbon income will only be possible where opportunities exist for farmers to engage in practices useful for their needs as well as carbon credit generation, such as good soil management that increases both soil carbon and crop yields (Lal 2004a; Roshetko et al. 2007). For those already using or considering agroforestry, carbon credits could allow farmers to realize earlier returns, which could allow some to participate who would not otherwise have sufficient resources to wait for longer returns from conventional products (Sathaye et al. 2001).

3.2 Project Cost and Community Participation

Much of the expected tension highlighted in Table 2 relates to the need of co-benefit projects to generate carbon credits at a cost low enough to be competitive on carbon markets while sustaining smallholder participation to deliver development benefits. On their own, forestry, smallholder and community-based projects, and sustaining participation in projects, each have high transaction costs (Boyd et al. 2007; Cacho and Lipper 2007; Harris 2007; Haupt and von Lüpke 2007; Roshetko et al. 2007; Smith and Scherr 2003). Generating carbon credits adds additional costs associated with measuring baselines, proving additionality, and monitoring (Cacho et al. 2002; Jindal et al. 2008; Leach and Leach 2004; Lile et al. 1998; Milne 1999; van Noordwijk et al. 2008). Not surprisingly, smallholder carbon projects, particularly those delivering substantial sustained benefits to local people, have higher transaction costs (Cacho et al. 2002; Milne 1999; Roshetko et al. 2007; Smith and Scherr 2003). Although it is believed to be possible, keeping costs down sufficiently for smallholder carbon forestry co-benefit project credits to be competitive with those generated in other kinds of projects is very difficult (Cacho et al. 2005; Nair et al. 2009). The tension between project costs and project participation plays out in both the Substantive and Process Project Characteristics.

3.2.1 Substantive Project Characteristics

Project costs are at the root of tensions for a number of Substantive Project Characteristics.

Participants and partnerships: For development benefits, there is an emphasis on building good relationships and communication in multi-stakeholder partnerships (Fischer and Vasseur 2002; Garrity 2004; Leakey et al. 2005). Although there are examples of carbon projects involving multiple partnerships (e.g. the voluntary market *Scolel Te* project described in Nelson and de Jong 2003), the carbon literature did not emphasize these practices, and Boyd et al. (2007) suggest that multi-stakeholder partnerships may be avoided in CDM carbon projects because they increase project costs.

Project size: Smaller carbon projects usually have higher transaction costs and lower profitability per hectare (Cacho et al. 2004; Cacho and Lipper 2007; Harris 2007; Leach and Leach 2004; Skutsch 2004; Smith and Scherr 2003; Torres et al. 2010). Transaction costs increased exponentially when farm size dropped below one hectare (Cacho and Lipper 2007). However, smaller projects are preferred for development benefits, in part because they are more easily adapted to changing needs and integrated with other activities (Boyd et al. 2007). Smaller farm sizes were preferred in Uganda where most farmers had less than a hectare for tree-based land-uses (Anderson and Zerriffi Unpublished Working Paper).

Monitoring: Verification of carbon credits requires expensive monitoring (Harris 2007; Leach and Leach 2004; Milne 1999). Monitoring is more expensive with smaller or more heterogeneous plots of land, projects involving dispersed landholders, and those seeking to deliver a large, diverse range of benefits (Cacho et al. 2004; Milne 1999).

Education and training: On-going knowledge transfer that is participatory and regionally appropriate is important for sustained development benefits (Boyd et al. 2007; Cacho et al. 2005; Chivinge 2006; Current and Scherr 1995; Dolan 2006; Fischer and Vasseur 2002; Roshetko et al. 2007; Rudebjer et al. 2006;Shiferaw et al. 2009). In carbon projects education and technical support may be minimal and/or short-term to save money. In projects in both Mexico and Costa Rica, technical support was discontinued or reduced to keep projects financially viable in the face of resource shortages (Milne 1999; Nelson and de Jong 2003).

3.2.2 Process Project Characteristics

Many of the practices emphasized for sustaining participation to realize development benefits are not emphasized for carbon benefits, likely because of additional costs that practices like flexibility and collaboration imply (Boyd et al. 2007).

Interaction with project context and integration with other activities: For co-benefits, projects should actively facilitate conditions favourable for project success and synergize with other development activities (Nelson and de Jong 2003; Roshetko et al. 2007; Sathaye et al. 2001). Carbon forestry projects are not always linked to other activities, and tend to focus on carbon sales rather than broader community development goals (Nelson and de Jong 2003; Nishiki 2007; Olsen 2007).

Flexibility in Project Design and Implementation: Flexibility facilitates development benefits because it allows people and projects to adapt to changing conditions and needs (Boyd et al. 2007; Fischer and Vasseur 2000; Roshetko et al. 2007; Shiferaw et al. 2009). Carbon projects favour more rigid, inflexible designs to simplify credit validation and reduce costs and fraud (Boyd et al. 2007; Harris 2007; Smith and Scherr 2003; Van Vliet et al. 2003).

Community Participation: Project “ownership” by local participants and incorporation of local knowledge through participatory and bottom-up processes are recommended by many authors for realizing development benefits (Boyd et al. 2007; Dolan 2006; Roshetko et al. 2007; Shiferaw et al. 2009). By contrast, carbon projects often use top-down decision-making and limit smallholder involvement to reduce costs and increase control by intermediaries tasked with ensuring a flow of valid, economically competitive (Boyd et al. 2007; Milne 1999).

Demonstration of Benefits: Many farmers are motivated to participate when they have opportunities to experiment and see results before they commit (Ashley and Carney 1999; Dixon et al. 1994; Fischer and Vasseur 2000; Roshetko et al. 2007). Demonstrating benefits could increase project costs, and is not and is not generally part of the design of carbon projects.

Market Availability and Access: To sustain participation and delivery of benefits, people must have access to markets for tree products destined for sale (Roshetko et al. 2007; Fischer and Vasseur2002). While direct connections between producers and markets are feasible for some physical tree products, carbon projects often use centralized brokers to connect credit producers to international markets (Nelson and de Jong 2003; Vatn 2010). Brokers can reduce local level decision-making and give considerable power to intermediaries, which is less desirable for development benefits (Boyd et al. 2007; Macqueen 2009; Leakey et al. 2005; Nelson and de Jong 2003; Vatn 2010).

4. Discussion and Implications for Agroforestry Project Design

While it may be possible to take advantage of some of the synergies between development and carbon in agroforestry, many of the tensions described may be difficult to resolve because the underlying approach of carbon mitigation and development projects are quite different. As described above, the literature reviewed reflects the fact that most of the smallholder development agroforestry efforts explicitly or implicitly take a participatory approach to development. This approach sees successful development as rooted in the sustained, broad participation and on-going support of local people (Hayward et al. 2004; Williams 2004), which the reviewed literature suggests usually means projects need to be context-specific and community-driven. Although smallholder carbon projects must also sustain participation, they must concurrently place a strong emphasis on carbon credit validity and keeping costs down in order to produce competitive credits. Our review suggests that many of the practices that help to sustain broad participation and community ownership are also often more costly and can make validation more difficult. This aligns with conclusions and findings in the literature that suggest that broad participation in carbon projects can be difficult to achieve: economic benefits from carbon are likely to be unevenly distributed (Tschakert et al. 2007) and flow primarily to middle-income farmers (Brown and Corbera 2003), and including carbon credit generation in smallholder tree planting projects can exacerbate many barriers that prevent certain community members, like the poor and women, from participating (Anderson 2010).

To effectively deliver development and carbon benefits in the same project, project designers will need to think carefully about how to overcome these inherent tensions when different kinds of benefits with different requirements for success are sought together. There are some possibilities for improving participation while keeping costs down, at least in theory. Some practices valued for sustaining participation and delivering development benefits, such as collaboration and increasing trust and engagement, may also have the potential to reduce project costs overall and increase project success (Boyd et al. 2007; Gong et al. 2010; Milne 1999; Vatn 2010). For example, working with established organizations could reduce costs associated with negotiation and training, and may increase the quality of development benefits generated (Cacho et al. 2005; Milne 1999; Nelson and de Jong 2003). Smallholder participation in project design and linking to other development and research activities could diversify funding opportunities, reduce costs and leakage, and increase monitoring effectiveness (Boyd et al. 2007; Milne 1999; Nelson and de Jong 2003; Roshetko et al. 2007; Smith and Scherr 2003). Other strategies to lower costs include focusing on the voluntary carbon market, generating revenue from conventional tree products, grouping smallholders or projects to increase size, increasing carbon prices, and diversifying carbon credit types (Boyd et al. 2007; Cacho and Lipper 2007; Cacho et al. 2005; Gong et al. 2010; Grieg-Gran et al. 2005; Harris 2007; Milne 1999; Niles et al. 2002; Palm et al. 2004; Smith and Scherr 2003; Torres et al. 2010; Van Vliet et al. 2003).

However, meeting smallholder needs and reducing project costs may be difficult in practice (Smith and Scherr 2003), especially where cost-reducing strategies require action outside of project control. This is reflected in the limited success of early projects to deliver co-benefits. Many of the recommendations made in the reviewed literature to improve co-benefit projects reflect recommendations for achieving development benefits from a participatory development perspective, without thoroughly addressing the implications of adopting these practices for project costs and tensions with practices in many successful carbon forestry projects. For example, Roshetko et al. (2007) make a number of suggestions about how successful smallholder carbon projects should be designed, such as collaborating closely with smallholders in project design and implementation. Although transaction costs are identified as a key barrier in smallholder carbon projects and some suggestions are made for lowering overall costs and securing additional funds, the impact that their specific suggestions for securing development benefits will likely have on project costs is not acknowledged or analysed. Similarly, Boyd et al. (2007) acknowledge that participatory process may be costly without concrete suggestions to address this issue. Given that it is challenging to keep costs sufficiently low in smallholder carbon projects generally (Cacho et al. 2005; Nair et al. 2009), the impact of increased costs due to participatory practices could be significant.

An alternative approach to trying to maximize co-benefits in a way that increases participation while reducing costs is to redefine the goals of agroforestry projects in terms of primary and ancillary benefits. This approach is discussed in the next sub-section, followed by some ideas around next steps for research in this area.

4.1 Ancillary Benefit Projects

For smallholder agroforestry projects to be successful, whether for carbon mitigation or development or both goals, requires realistic expectations. Meeting expectations is important to maintaining the trust necessary to maintain good relationships between project stakeholders and achieve success (Fischer and Vasseur 2002). The sustainability of smallholder agroforestry projects and their ability to attract and sustain funding and the participation of smallholders will likely be compromised if projects fail to meet expectations or fall short of their own goals, as it appears a number of co-benefit projects have (e.g. Brown and Corbera 2003; Nelson and de Jong 2003; Anderson and Zerriffi Unpublished Working Paper). Discussing carbon forestry projects initiated under REDD[3], Corbera and Brown (2008) suggest that “an overemphasis on co-benefits” can lead to a decrease in project investment, and suggest simplifying where possible.

An alternative to a co-benefits approach that would make expectations clearer and more realistic while also simplifying project design is an ancillary benefits approach. In this approach both goals are sought intentionally but not necessarily co-maximized. Instead, the project is explicitly designed to achieve one goal (carbon mitigation or development) as its primary outcome while finding opportunities to maximize the spillover or ancillary benefits to the other. For example, an agroforestry project may be designed with a primary goal of delivering livelihood improvements to local people, but include carbon credit generation to bring additional income and earlier returns to farmers. In this case, the project would likely have to be sustainable on its own (i.e. not rely on carbon credits for success).[4] The carbon credits produced might not be maximized if certain choices are made that are considered important from a development perspective (e.g. more flexibility in use of tree products), but could still provide some additional monetary benefits. By contrast, a large carbon forestry project prioritizing carbon credit generation could use money from carbon finance to fund community development activities to promote community support and reduce leakage.

In each case, the project is designed first for success in the area of primary interest; any conflict between best practices for each type of benefit is resolved in favour of the primary goal. But, where practices are not in conflict, the project is designed to take into

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[3] Reduced Emissions from Deforestation and Forest Degradation, an approach to reducing global emissions linked to forest sources. REDD (now generally referred to as REDD+) includes project-based approaches, which could potentially include smallholder agroforestry.

[4] Similarly, Roshetko et al. (2007) suggest that co-benefit projects should be socially and economically viable without carbon revenue, which could be viewed as a strong version of the ancillary benefits argument. However, this would also reduce the potential for synergy from additional carbon revenue.

consideration and then capitalize on opportunities for alignment or synergy to deliver ancillary benefits for the secondary goal. This was the approach taken by a commercial carbon project in Uganda, Global Woods, which focuses primarily on carbon credit generation. (Anderson 2010). Due to costs and tenure complications, local farmers do not currently participate directly in carbon credit generation; however, the employment opportunities and development programs provided by the company make revenues and benefits available to the community, including those who would be unable to participate in carbon tree planting on their own land (e.g. the landless) (Anderson 2010). Although more research would be needed to explore in detail the distribution of different costs and benefits in this approach, an independent, community-reviewed report suggests that local people are benefiting, and are supportive of the approach (Heifer International 2010).

These different approaches each would have their own set of tradeoffs and factors necessary for success. There are good reasons for the emphasis on participatory development in the literature, and for the wide acceptance of links between community participation and the success of development efforts more generally (Pieterse 1998). These include connections between participatory processes and initial and sustained participation of smallholders (Roshetko et al. 2007; Shiferaw et al. 2009), and the more equitable of distribution of benefits that would be expected from participatory development’s emphasis on broad participation (Hayward et al. 2004; Williams 2004). Alternative approaches that emphasize carbon credit generation first and development as an ancillary benefit would have to take into account and be explicit about the kinds of development benefits being delivered and to whom.

An ancillary approach could be an intermediate step that allows project implementers to simplify trade-offs and project design, set more realistic expectations, and secure resources, potentially getting projects off the ground more quickly while progress is made to improve the co-benefit approach. An ancillary approach may also be preferable in some cases: for example, since maximization does not take into consideration factors like thresholds, an ancillary approach could help project implementers to avoid trade-offs they don’t actually want to make. For example, maximizing overall benefits could result in an imbalance in climate versus development benefits, fail to address specific climate or development priorities, or fail to deliver adequate benefit to reach a critical threshold that project designers might want to reach, such as a level of income considered the threshold for raising households out of poverty. Wherever an ancillary approach is taken, it will be important to have some level of integration and coordination to ensure that different projects do not work at cross-purposes.

4.2 Next Steps

Whether carbon finance can deliver the synergy and co-benefits hoped for in the literature will depend on interactions between global and local factors. More research is needed if agroforestry is to effectively deliver benefits for rural development and global climate in a manner that is equitable, effective, and acceptable to all stakeholders. Further research will be useful to determine how best to resolve inherent tensions in co-benefit projects, and to what extent and in what circumstances an ancillary approach to project design may be useful. Where a participatory approach to development is combined with carbon credit generation, it will be especially important to consider how initiatives to improve development outcomes will affect project costs. Considering the variability in agroforestry technologies, carbon markets, and project contexts in particular, more detailed case studies to explore the nuances of how specific project characteristics and practices are linked to the delivery of development and climate outcomes will be important. In the meantime, a focus on an ancillary benefit approach to project design could make larger, timelier contributions to addressing climate change mitigation and human development priorities, while providing valuable opportunities to improve the design of smallholder agroforestry projects operating with multiple goals, many beneficiaries, and across scales.

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