ASB Partnership for the Tropical Forest Margins

Policybrief 48

Smallholder Agroforestry Contributions to REDD+ in the Kinshasa Woodfuel Supply Basin, DRC

Summary

The adoption of smallholder agroforestry systems has the potential to address the two main drivers of deforestation in the Kinshasa woodfuel supply basin in the Democratic Republic of Congo (DRC), slash-and-burn agriculture and woodfuel production. Further, it can contribute to the dual objectives of climate change mitigation and improving livelihoods through the DRC's Reducing Emissions from Deforestation and forest Degradation (REDD+) program. Here we estimate the potential contribution of six different *Acacia*-cassava smallholder agroforestry systems to carbon sequestration, woodfuel production and income generation in the Kinshasa woodfuel supply basin. The overall potential woodfuel that can be supplied sustainably within the basin from increased woodfuel supply and reduced demand is also assessed. We further discuss the potential of including smallholder agroforestry systems within the REDD+ framework in the DRC highlighting both opportunities and barriers.

Key Messages

- Agroforestry systems should be promoted for the delivery of multiple benefits both within and outside a REDD+ framework, but need to be deliberately designed to ensure potential tradeoffs between benefits are reduced
- Adoption of agroforestry practices can make large contributions to both mitigation and adaptation within a REDD+ framework but inclusion of smallholder systems face challenges related to economies of scale
- REDD+ can act as an enabling framework for the adoption of agroforestry, providing financial, political and technical support, but carbon finance alone is not enough to incentivize adoption
- Higher carbon credit prices can further incentivize carbon sequestration and woodfuel production benefits as they generated relatively low income in the scenarios explored

Policy Recommendations

- Agroforestry should be promoted as a sustainable land use practice both within and outside the framework of REDD+ as it can address climate change mitigation and adaptation as well as drivers of deforestation
- Strengthening land tenure or land use rights, developing supply chains, increasing access to markets, providing extension services and increasing access to finance can help to incentivize smallholder investment in the adoption of agroforestry systems
- Government and other actors need to co-invest in smallholder agroforestry given that while carbon finance can provide some upfront financing, alone it may be insufficient to stimulate desired multiple REDD+ adaptation and livelihood benefits
- Alternative renewable energy sources should be sought alongside increased sustainable woodfuel supply to further reduce demand for woodfuel and its impact as a driver of deforestation and forest degradation

Deforestation and Forest Degradation in the Kinshasa Woodfuel Supply Basin

The Kinshasa woodfuel supply basin is one of the DRC's 'hotspots' of deforestation (Schure et al. 2014a). It encompasses the area surrounding the Democratic Republic of Congo (DRC)'s capital city Kinshasa that supplies 77% of the city's woodfuel demand. This area is estimated to be 933,935 hectares in size (Boulogne et al. 2013). The two main drivers of deforestation here are slash-and-burn agriculture and woodfuel production, including both charcoal and firewood. Smallholder farmers, constituting the majority of the population in the supply basin, clear new plots for cultivation as population rises and land degradation expands. The high demand to meet Kinshasa's wood-energy needs puts further pressure on forest galleries (pockets of forested areas) and woody savanna areas.

To address drivers of deforestation within the country, the Government of DRC has been involved in the Reducing Emissions from Deforestation and forest Degradation while fostering conservation, sustainable management and enhancement of forest carbon stocks (REDD+) mechanism. REDD+ was designed as an international climate policy mechanism to foster climate change mitigation through enhancement and preservation of forest carbon stocks. In the DRC, REDD+ aims to address multiple goals including climate change mitigation and livelihood improvement.

Agroforestry, practices that intentionally integrate and manage trees in farms and landscapes, has been identified to be able to address both of these objectives within a REDD+ framework in the DRC. Agroforestry can act as a source of sustainable woodfuel supply and a carbon sink. It can also facilitate sustainable intensification by improving soil through nitrogen-fixing species and increased organic matter inputs, reducing land degradation and the need to expand cultivation into new areas. Thereby it can address both of the main drivers of deforestation. Furthermore, diversification of agroforestry systems can create additional economic opportunities to increase household income improving livelihoods.

Agroforestry Contributions to Carbon Sequestration, Woodfuel and Income

Applying carbon accounting and cost-benefit analysis methods, potential contributions of six different *Acacia*-cassava based agroforestry systems (Table 1) to carbon sequestration, woodfuel production and income generation were estimated and compared with two baseline scenarios over a 30-year period, an acceptable crediting period for REDD+ projects. Scenario estimates are based upon 5 hectare areas with 0.5 hectare baselines. A family in the DRC is estimated to manage between 5-10 hectares of land cultivating 0.5-1.5 hectares at a time with the rest left fallow (Pollini 2015). Therefore the assumption is a family will adopt the agroforestry system within the entire area of land they manage here assumed to be 5 hectares, compared to the 0.5 hectare baseline scenario.

Acacia-cassava agroforestry systems were chosen as cassava is the main staple food crop grown and consumed in the DRC with *Acacia* acting as a fast-growing species that fixes nitrogen, improving soil quality, and can produce charcoal within five to eight years. Two *Acacia* rotation systems are included: a two-year rotation system (A2) cultivating 2.5 hectares per year and growing *Acacia* for its nitrogen-fixing properties to improve soil quality; and an eight-year rotation system (A8) cultivating 0.625 hectares a year where *Acacia* is grown to produce charcoal for the Kinshasa market contributing to the basin's woodfuel supply.

For estimates of supply basin level contributions it is assumed each agroforestry system scenario was adopted within fallow areas in the supply basin, approximately 23% of the area (Boulogne et al. 2013). The total amount of woodfuel that could be sustainably sourced if increasing supply through the adoption of the agroforestry systems, and reducing demand through improved charcoal production efficiency and the adoption of more efficient charcoal cookstoves is also estimated using carbon accounting methodologies.

Table 1 and Figure 1 present potential contributions that can be made to carbon sequestration, woodfuel production and income generation. They demonstrate agroforestry systems can achieve benefits for all three objectives, but tradeoffs exist between the benefits achieved across the different systems.

To promote all three objectives, agroforestry systems need to be diversified with activities beyond *Acacia* and cassava, including longer-growing tree species for increased carbon sequestration, and growing *Acacia* on longer-growing cycles to produce charcoal profitably and contribute to the basin's supply. Although A2 systems technically can produce more charcoal than A8 systems, due to the shorter growing period in A2 systems requiring more frequent planting and harvesting activities, it is not a profitable activity and the charcoal produced from each harvest is so small it can only be used for household consumption or sold in the local market. Furthermore these systems sequester less carbon. But given the larger area of land cultivated each year. Although A2 systems technically can produce more charcoal than A8 systems, it is not a profitable activity due to the shorter growing period in A2 systems requiring more frequent planting and harvesting activities,

Table 1: Scenario descriptions for the six agroforestry scenarios and two baselines and their contributions to carbon sequestration (tCO2e), woodfuel production (t charcoal) and income generation (USD) represented in average amounts per year over the 30-year period. Net present value (NPV) using a 12% discount rate over the 30 years is also included. Species and activities included in scenarios and baselines are as follows: *Acacia auriculiformis* (*Acacia:* A8; A2); *Manihot esculenta* (Cassava: Cas); Zea mays (Maize: Mz); *Sorghum bicolor* (Sorgm: Sor); *Dacryodes edulis* (Safou: Saf); *Terminalia superba* (Limba: L); and bee keeping (Honey: H).

Agroforestry Scenarios	$tCO_2e\ yr^{-1}$	t charcoal yr^{-1}	USD yr^{-1}	NPV 12% 30 yr^{-1}
A8 x Cas	1,108	134,842	643	5,455
A8 x Cas x Mz x Saf x H	2,292	120,819	12,997	63,800
A8 x Cas x Sor x L	1,457	120,819	1,190	7,975
A2 x Cas	262	170,018	1,316	10,382
A2 x Cas x Saf x H	1,532	150,976	12,916	64,063
A2 x Cas x Mz x L	996	150,976	4,643	35,514
Baseline Scenarios				
Cas	N/A	N/A	274	1,941
Cas x Mz	N/A	N/A	837	6,473

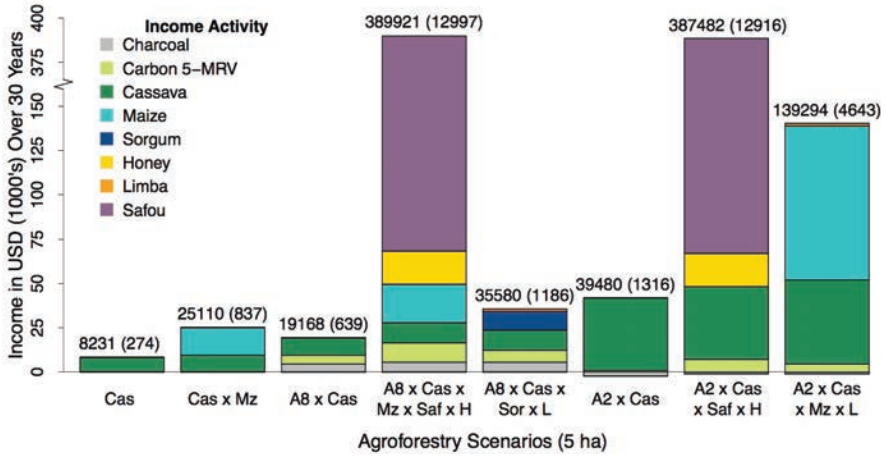

Figure 1: Potential income that can be earned for each different scenario over the 30-year period broken down by income-generating activity in USD compared to the two baselines. The numbers above each bar represent total potential income over the 30 years with the average yearly income in parentheses. Note the break in the y-axis due to the significantly greater amount of income projected from the sale of safou fruit.

and the charcoal produced is so small it can only be used for household consumption or sold in the local market. For carbon payments, at the price assumed received per carbon credit, 5 USD minus monitoring, reporting and verification (MRV) costs, they make relatively small contributions and are not enough to incentivize the adoption of agroforestry practices alone (Figure 1). Additionally, income from charcoal production is less than if sourcing it for 'free' from forest galleries and woody savanna where trees do not need to be planted nor require waiting for them to grow.

When looking at the time value of money over the 30 years, all scenarios result in a positive NPV (Table 1), demonstrating all are profitable even when making longer-term investments in tree-based activities. As the values represent averages per year there is a need for both upfront investment and accounting for yearly lows when designing agroforestry systems. These can act as barriers for adoption if smallholders do not have the means to weather low income years or the ability to invest in the systems.

Therefore to address all three objectives adequate incentives are needed for smallholder farmers to adopt A8 agroforestry systems as they can make significant contributions to carbon sequestration and woodfuel production at the basin scale (Table 2), but are not as economically competitive as other systems and require long-term upfront investments. Diversifying A8 systems with activities such as growing the local fruit tree safou for the sale of fruit and bee keeping for the sale of honey can make substantial contributions to income benefits (Figure 1). Furthermore, increasing the scale at which the systems are adopted will result in increased income due to larger areas being cultivated each year, but will also require more labor.

Contributions to REDD+

Adoption of agroforestry systems within the Kinshasa woodfuel supply basin has the potential to make large contributions under a REDD+ framework. The Maï Ndombe Emission Reduction Program, the largest REDD+ program at the jurisdictional level in the DRC, estimated net emission reductions totals 219.23 million tCO_2e over a 35-year period from 2015-2050 (FCPF 2014). If agroforestry systems were taken up in fallow areas of the supply basin this could result in a 45% contribution to these targets (Table 2). Furthermore, adoption of A8 systems can increase the amount of woodfuel sustainably supplied within the supply basin by 7%. Combined with reduced woodfuel demand from adoption of more efficient charcoal production and charcoal cookstove technologies, this can result in up to almost 13% of the woodfuel in the supply basin being sustainably sourced (Table 3).

Still, despite these significant contributions there are a number of challenges in including smallholder agroforestry systems within a REDD+ framework some of which are outlined in Table 4 alongside potential opportunities and suggestions for addressing barriers.

Table 2: Total potential contributions of carbon sequestration and woodfuel production if the different scenarios were adopted in all fallow areas in the Kinshasa woodfuel supply basin. Relative contributions to Maï Ndobme's expected emission reductions and woodfuel supply within the supply basin are also included.

	tCO2e (30 years)	Relative Contributions to Maï Ndombe Expected Emission Reductions (%)	Woodfuel t (30 years)	Relative Contributions to Basin Supply (%)
A8 x Cas	47,965,318	22%	4,045,264	7%
A8 x Cas x Saf	99,233,017	45%	3,624,557	7%
A8 x Cas x L	63,083,087	29%	3,624,557	7%
A2 x Cas	11,360,332	5%	5,100,551	9%
A2 x Cas x Saf	66,337,336	30%	4,529,289	8%
A2 x Cas x L	43,115,939	20%	4,529,289	8%

Table 3: Estimates of the potential woodfuel that can be supplied sustainably within the supply basin through increased supply from the adoption of agroforestry systems and reduced demand from the adoption of more efficient charcoal production methods and charcoal cookstoves. Adoption rates of the more efficient technologies were assumed to be 50% and 100% in the estimates.

Adoption Rates	Demand % Demand Reduced		Supply % Supply Increased in the Supply Basin	Potential Sustainable Woodfuel in the Supply Basin**
	Cookstoves	Charcoal Production		
50%	7.3%	3.75%	7%*	11.2%
100%	14.6%	7.5%		12.8%

*For A8 scenarios as these are the only profitable charcoal scenarios even though A2 scenarios can technically produce more (Table 2)

**Assuming 3% was already sustainably sourced (Schure et al. 2014b)

Enabling Conditions

High transaction costs are associated with including activities at the scale of smallholders in REDD+ as aggregating these activities requires more complicated and intensive coordination and monitoring processes. Cooperatives or contract farming can assist in aggregating these activities and can act as an entry point to improve farming and agroforestry practices through trainings, farmer-to-farmer learning and extension services. This can also create the opportunity to better access finance through micro or group lending to enable investment in agroforestry systems as tree-based products take longer time frames to generate returns. Upfront carbon finance is one opportunity to provide initial financing for such long-term investments, but may be limited in total amount.

Increasing income earned through diversification and increased scale of agroforestry systems will help to provide larger financial incentives for investment. But farmers might see investing in new, unknown systems as risky. Providing more secure land tenure or land use rights may help as an incentive in this process. Further, drawing on extension services to provide training and resources can assist in promoting the establishment of agroforestry systems.

Way Forward

In the run-up to the UNFCCC COP 21 in Paris, this study highlights the tremendous potential of agroforestry to complement REDD+ and related Intended Nationally Determined Contributions (INDCs) strategies at the heart of discussions in the negotiations. There are opportunities to draw from the Green Climate Fund (GCF) and other INDC-related funding to complement REDD+ and agriculture-related finance for agroforestry in the service of multiple climate (adaptation and mitigation) and livelihood objectives. This study lays the foundation for agroforestry deployment in REDD+ in the DRC as well as more generally within climate change, multiple Sustainable Development Goals (SDGs), and low-emission development frameworks in Africa.

Table 4: Some opportunities and barriers for the integration of agroforestry systems within in a REDD+ framework in the Kinshasa woodfuel supply basin.

Opportunities	Barriers	Actions that can address barriers
Use the REDD+ framework as an enabling mechanism to promote green development	Need economies of scale for REDD+ projects not favorable for small-scale farmer activities	Contract farming; cooperatives
Address the two main drivers of deforestation within a REDD+ framework	Insecure or unclear land and carbon rights	Granting land/resource managers the rights not owners; strengthening recognition of customary land use rights
Support diversification of livelihoods promoting climate change adaptation in addition to mitigation	Significant financial and technical resources needed for certification and MRV processes	Investment opportunity for development
Potential for long-term adoption of practices delivering benefits beyond the REDD+ framework	Implementation in a post-conflict state with weak governance, institutions and capacity	Build on ongoing initiatives before scaling up activities

The ASB Partnership for the Tropical Forest Margins is working to raise productivity and income of rural households in the humid tropics without increasing deforestation or undermining essential environmental services.

ASB is a consortium of over 90 international and national-level partners with an ecoregional focus on the forest-agriculture margins in the humid tropics. The partners have established 12 benchmark sites in the tropical forest biome of Brazil, Cameroon, Indonesia, Peru, Philippines and Vietnam.

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