TECHNICAL BRIEF

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Issue No. 1

Carbon off-set options for the FunciTree Project

Evaluating carbon off-set options from a buyer's standpoint using private and social feasibility criteria

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Carbon off-set options
for the FunciTree Project

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The FunciTree Project has allocated a budget of €14400 for off-setting project related emissions of GHG, primarily associated with project participants' air travel. We discuss four different options for off-setting emissions and evaluate their respective cost-effectiveness: 1) purchase of regulatory or certified emissions reductions from the EU emissions trading market or CDM projects; (2) purchase of Verifiable Emissions Reductions (VER) from a retailer in the voluntary market; (3) purchase directly from a voluntary off-set project; (4) design , pilot and certify FunciTree's own carbon off-set project in cooperation with the Millenium Villages Project. We find that direct purchase of VER carbon certificates from the Plan Vivo appears to be the most cost-effective use of FunciTree funds. Given FunciTree's aims of evaluating the feasibility of enhancing ecosystem services from agro-forestry systems, we also evaluate the financial and economic feasibility of a "FunciTree off-set pilot off-set project" (4). From a financial stand point FunciTree's budget will only cover about 1/3 of the costs estimated to design, pilot and certify an off-set project with Plan Vivo. The pilot project area required to off-set FunciTree's emissions using a mix of *Faidherbia albida* (Balanzan) and *Vitellaria paradoxa* (Karité) was estimated at around 4 hectares. We also evaluated the economic feasibility of up-scaling the project to sell Plan Vivo carbon certificates after termination of the FunciTree research project; we included potential long term benefits from firewood and some other non-timber products over a 45 year period. By distributing fixed costs over a larger project area, and accounting for mainly firewood benefits, we estimate that a project is economically feasible at >450 hectares (discount rate of 8%). Sensitivity analysis of the break-even carbon certificate price, shows the project being economically attractive at around 20 €/tCO2. Valuation of fodder and food security benefits could be expected to decrease this minimum feasible project area, and break-even certificate price further. We conclude that there is an economic case for seeking cooperation with the Millenium Villages Project to co-finance a carbon-off set project using low cost Assisted Natural Regeneration.

Photo cover: David N. Barton

Appreciating trees only for their carbon "is like valuing a computer chip only for its silicon" (Tom Lovejoy in The Economist, September 25th,). Among FunciTree's aims is to evaluate and test agro-forestry systems that improve livelihoods and enhance ecosystem services, by increasing their functional diversity.

Introduction

FunciTree has budgeted for mitigation of CO_2 emissions from international project travel. In the project proposal this was to be spent on purchasing carbon off-sets from an international retail provider. At the current off-set prices(2010) FunciTree has set aside more than sufficient funds to pay for off-sets for international air travel of the project(see text box). This has been the starting point for evaluating options to retail purchase of off-sets that would be synergistic with FunciTree's research objectives.

Carbon off-set options

1.Regulatory off-sets : EUA or CER

Certain countries such as Norway offer the private sector the opportunity to purchase carbon off-sets from the total emissions quotas agreed under the Kyoto Protocol. These are regulatory compliance off-sets. Off-sets purchased here are withdrawn from the Kyoto protocol quota of emissions permits. The Norwegian EPA provides an off-set service (http://co2.sft.no/) where private entities can purchase quotas from the European Union (EUA) quota trading system or Clean Development Mechanism's (CDM) Carbon Emissions Reductions (CER).

> At present off-set prices and an assumption that 1/3 of FunciTree travel is between Paris(Europe)-Managua (3.75 tonnes CO_2e or €93 per roundtrip) and 2/3 between Dakar(Africa)-Paris(Europe) (1.71 tonnes CO_2e or € 42 per roundtrip), FunciTrees off-set costs for voluntary off-sets purchased from MyClimate would be approximately a total €2837. This is a conservative estimate for international air travel, not counting local travel within the project countries. FunciTree has budgeted Euro 14400 for mitigation of CO_2e emissions from international project travel, calculated as 20% of international air travel (over a total of 48 flights during the project).

The difference with the voluntary off-sets is that, carbon emissions quotas purchased cannot be linked to any specific or portfolio of projects. Also carbon quota prices change with the market price: with the current financial crisis and low oil price, carbon quota prices are also low. Current price for regulatory carbon quotas is approximately 18 €/tonne CER and 19,5 €/tonne EUA (May 2010)

2.Retail voluntary off sets: Verifiable Emissions Reductions (VER)

An example of an international retail provider is MyClimate http://www.myclimate.org/en.html. Off-sets on sale have been "produced" by a portfolio of projects identified on the MyClimate website, most of which are related to some form of energy switching (http://www.myclimate.org/en/carbon-offset-projects/international-projects.html). Providers such as MyClimate are subject to third party review (http://www.myclimate.org/en/portrait/reactions-to-myclimate/studies.html). Their projects comply with the "CDM Gold Standard" (http://www.cdmgoldstandard.org/) , which is a certification system "Certified Emissions Reductions" originally promoted by the WWF. Off-set certification complies with CDM standards which were designed for regulatory compliance, but may go further in certifying other aspects of the projects which are attractive to the voluntary market. These off-sets are called "verifiable emissions reductions". Gold Standard projects have to contribute to local community sustainable development objectives in addition to carbon off-sets. Sustainable development and conservation benefits in addition to carbon mitigation are often called "co-benefits" in the jargon of initiatives to reduce emissions from forest degradatation and deforestation (REDD). Off-set prices are based roughly on project level costs & administration fees and do not vary with the price in the regulatory carbon off-sets market. Current price for voluntary off-sets from MyClimate is approximately 25 €/tonne.

3. Direct purchase of VER from projects

FunciTree partners have suggested identifying established carbon off-set projects in the countries where FunciTree is involved and buying voluntary off-sets from them directly. Examples of projects that FunciTree partners have initiated have not been forthcoming, so an alternative is to purchase credits directly from existing projects elsewhere. While not operated by FunciTree partners, the identification of a specific project in the voluntary market, rather than unspecified off-sets, provides FunciTree researchers the opportunity to evaluate project results using competencies within the FunciTree project. Examples of specific projects include:

1) **MyClimate Projects**: e.g. Efficient cookers in Peru: http://www.myclimate.org/en/carbon-offset-projects/international-projects/detail/mycproject/31/53.html
2) **CDM/MyClimate Project,** e.g. Power from biomass, Bihar India http://www.myclimate.org/en/carbon-offset-projects/international-projects/detail/mycproject/6.html
3) **Vivo Plan Scolol Té, Mexico** : Afforestation, reforestation, agroforestry, forest conservation and restoration. http://www.planvivo.org/?page_id=49

Given FunciTree's agroforestry focus, purchasing off-sets directly from a Plan Vivo project, which focuses on agroforestry, reforestation and forest protection would be most relevant for research. Plan Vivo has its own certification system which is offered to member projects. Unlike MyClimate, carbon off-sets are bought through direct contact with the project. In addition to the largest project of almost 5000 hectares in Scolol Té, Mexico, Plan Vivo currently has projects in Nicaragua, Tanzania, Uganda and Mozambique. A number of projects in agroforestry are currently in the pipeline, including tree species such as *Faidherbia*

Parkland Mali Photo: David N. Barton

albida. Certificates are registered with http://www.markitenvironmental.com/ and tracked with unique serial numbers to avoid double selling. Carbon credits in Plan Vivo projects vary in price depending on agreement between the project and buyer, but have typically been in the range €10-18/tCO2.

4. Develop and pilot test a carbon off-set project

FunciTree will interact with a large number of farmers at the three case study sites. The project aim is to propose new AFS which improve livelihoods and ecosystem services. For some AFS changes this may mean "additional" carbon mitigation effects through increased carbon sequestration, or possibly avoiding future loss of carbon storage. If these carbon mitigation effects are comparable to other certified agro-forestry projects, FunciTree may have the capacity to support local NGOs in developing the documentation required to certify AFS in one of the case study areas.

Initial discussions with the Millenium Village Project (MVP) Mali lead us to evaluate a FunciTree designed carbon off-set project in the context of MVP's cooperation with villages in Tiby, near Ségou. The project could in principle be evaluated in the same way for any of the other two case study sites in Sénégal or Nicaragua. In the case of MVP in Mali and Sénégal an off-set project would have the benefit of working within established integrated development projects that already have on-site experiences with agroforestry.

Project outline

Site description

Tiby I and II are two villages within the municipalities of Dioro and Farakoumassa, participating in the Millenium Villages Project (MVP). The total surface area of the two municipalities is 70 300 ha. (PVM, Samaké *et al.,* 2008). In this project area 15 000 hectares of lands are cultivated for rice and are unavailable for off-set activities; some lands are very old fallow lands (their precise surfaces are not known) and are not favourable to such a project. There are at least 30 000 hectares of dry crops (millet, sorghum, etc.) that could be appropriate for the off-set project, although not all of this area would be available, because individual farmers would need to agree to implement some regeneration programs in their fields. (pers. com. B.Kaya)

The municipalities of Dioro and Farakoumassa where the MVP is located includes a total of 5457 UPA (Unité de Production Agricole (UPA) (Samaké, et al. 2008)

In 2007, 185 farmers from 28 villages in the two municipalities were trained in establishing nurseries (pépinière). This represented about 34% of all the UPAs in the two municipalities. (Samaké *et al.,* 2008). 55% of UPAs in the MVP area participated in agroforestry training in 2006-2007 held by ICRAF. 42% of the population expressed an interest in participating in agroforestry practices (Samaké , 2008).

Of the total area planted with fruit trees by the ICRAF project, only 3% was maintained due to the large amount of irrigation and protection required (Samaké, et al. 2008). Farmers were more interested in training regarding 'plant schools' and plantations than in grafting techniques (Samaké, et al. 2008).

Very little interest was shown in introducing species for foraging by the population, despite the importance of grazing. Due to roaming livestock / grazing there was a large interest in live fence species, permitting farmers to demarcate and keep out livestock.

Samaké et al. (2008) recommended combining plantations with Assisted Natural Regeneration (ANR). ANR has the advantage of not requiring nurturing or purchase of saplings, and is not exposed to losses during transport of saplings. On the other hand, in ANR it may be more costly in the first 2-3 years to protect against physical damage and browsing from livestock. With plantations, an area can be more easily fenced.

Assisted Natural Regeneration (ANR)

Tree survival rates as low as 2% of introduced agroforestry species have been observed in Sahel (pers.com. Régis Peltier). This had been due to plantation in very poor soils (plateaux latéritiques, zipélé, Hardé, etc.), little maintainance, damage by grazing, insects, rats and fire. The ARN project discussed here is not proposing to plant trees in savannah land with poor soil conditions, but on crop land. Restoration of fallow land would require "improved fallow" techniques which are more complex and costly and not considered in this proposal. Since the introduction of mechanized tillage (tractor) parkland trees are no longer naturally regenerated when the land is cultivated. It is therefore necessary to partition or to surround the plots cultivated by uncultivated strips, on which vegetation can grow, and where ANR can be practiced. These bands will also play a role in erosion controll, if they are oriented along contour strips. Encouragement of natural regeneration would take place in cultivated and fertile land, so there is less uncertainty regarding growth conditions of trees. In alluvial soils near the Niger River, with groundwater close to the surface, like at Tiby, and in privately owned land, survival rates may be as high as 90% of planted saplings This is true for fenced plantations, home-garden or orchards. But, with ARN, to restore ageing parklands, survival rates as low as 20% may be acceptable because young trees are free and numerous. (pers.com. Peltier).

Parkland grazing near Tiby villages, Mali.
Photo: David N. Barton

Scope of financial and economic feasibility analyses

Financial feasibility analysis was conducted on project cash flows in a pilot stage lasting 18 months and a scaled up phase with an analysis horizon of 45 years. Costs of project design, implementation and certification were taken from Plan Vivo Scolol Té project website and Torres et al. 2010. We adjusted all labor costs from the Scolol Te project by a ratio of 0.2 Mali/Mexico to reflect differences in cost levels. Only income from the sale of carbon credits was accounted for in the financial analysis, where feasibility is seen from the perspective of the carbon off-sets project only.

The economic feasibility analysis takes a broader accounting stance, including as far as possible all benefits and costs of the off-sets project to farmers and local communities. Based on secondary data we evaluated the project lifetime value of sustainable fuelwood (*Faidherbia* and *Vitellaria*), as well as multiple products harvested from *Vitellaria*. Opportunity costs of increased tree density on crop yields were assumed to be negligible at the target density chosen.

Other impacts not evaluated

We had no data on the forage value of either tree species or their importance for food security in the dry season - these benefits were given a value of zero in the analysis.

The uncertainty regarding permanence of off-sets was evaluated using a sensitivity analysis of % risk of farmer defaulting on obligation in the project area (Appendix 1, Figure A1).

Of high importance in certification of VER schemes such as Plan Vivo are co-benefits in terms of community participation in project design and livelihoods improvement. Recently, in the context of REDD+, co-benefits to biodiversity have also received increased attention in certification.

None of these potentially positive effects were evaluated in the economic feasibility analysis. However, they are or will be subject to research within several activities within FunciTree in the proposed area. For example, in practice a ANR project would not be limited to two species. While the financial feasibility study focuses primarily on two species, during project implementation farmers would be encouraged to keep many other species using ANR. There are currently more than 20 trees species in the parklands (pers. com. Peltier). We also note that the presence of trees allows the development of a range of animal and plant diversity, in soil and canopy.

Analysis Assumptions

Costs

Project concept, design, planning and preparation (months 1-6): ca. € 34 000

Pilot project implementation, validation and certification (months 7-18): ca. € 8000

Project scaling up (450 hectares project):

-Operating costs project office: ca. €8250/yr. (fixed)

-Compensation to farmers: ca. €13500/yr. (variable see below)

-Monitoring costs: €6650/yr.

Income from off-sets

FunciTree's off-set needs in a pilot project amount to 115 tCO_2 or around €2000 (17,5 €/tCO_2). Carbon off-set certificates sold in project scaled up to around 450 hectares: off-setting ca. 14 000 tCO_2 is ca. € 245 000.

ANR technique

Based on studies by Peltier et al. (2007) ANR would have a target of around 60 trees/hectare. At this level of density we assume that crop productivity is not affected (pers.com. Peltier). In order to obtain 60 trees/ha roughly 160 trees should be planted/protected per hectare (about every 8x8 meters). Where ANR does not produce sufficient natural seedling, the remainder are sewed or planted. Mortality rates of 25% could be expected, leaving about 120 trees (pers.com. Régis Peltier). A further 10-20% would be damaged by grazing, leaving roughly 94-108 trees/ha. After 10 years the 60 best trees would be selected and the rest harvested for e.g. firewood. We have further assumed a risk of farmers defaulting on obligations of around 20%. In summary, we assume an ANR scheme where compensation would be given farmers for initially protecting around 200 saplings/ha.

Tree species

We assumed a mix of plantation of *Vitellaria paradoxa* (1000 FCFA/sapling) and assisted natural regeneration of *Faidherbia albida*. We sensitivity tested the % proportion of each species, given that establishing *V. paradoxa* is more costly than that of *F. albida*. (Appendix 1; Figure A2).

Other parkland species (*Parkia biglobosa* (Néré), *Adansonia digitata* (Baobab), *Detarium microcarpum*, *Prosopis africana* (African Mesquite), etc.) were not considered, but could be introduced into the feasibility analysis if biomass stock and sustainable harvesting data similar to those in Peltier et al. (2007) are available.

Compensation

Peltier et al. (2007) report a successful ANR scheme in North Cameroun where as little as 0,2 $/tree was sufficient to promote protection of saplings. Based on this experience the following compensation structure was evaluated: Year 1: 200 FCFA/ tree; year 2: 100 FCFA/ tree, year 3: 100 FCFA/ tree. Subsidies for plantation would be for the same amounts.

Trees effects on agricultural productivity With *F. albida*, agricultural production is in theory improved, but research has not been able to demonstrate improvements before 15 years after plantation. For adult trees (>40 years) increases in crop productivity may be as high as 20% relative to cropland without trees (pers.com. Peltier).

With *V. paradoxa*, and almost all species with foliage during the cropping season, there is a small yield loss which could reach 10-15% for older tress (>50 years). This economic loss is more than compensated by the production of fruits, branches for firewood, building materials, forage, honey and Karité butter. As an estimate of these net benefits we use net income to *Vitellaria* Parkland estimated by Boffa et al. (1999).

Sustainable production of fuelwood from *F. albida* and *V. paradoxa* were based on Peltier et al. (2007) and Smektala et al. (2005), respectively.

Further assumptions used in the financial and economic analyses are presented in Appendix at the end of this Brief.

The spreadsheet used to model feasibility (CBA carbon-offsets Tiby.xls) was run with @Risk add-in to simulate uncertainty in key parameters using a Latin Hypercube simulation technique. Sensitivity analyses were also run in @Risk (www.palisade.com).

Modeling results

1.Cost-effectiveness and the break even carbon off-set price

As a first step, we compared the off-set price at which the present value of costs in the project would equal the present value of income from the off-set (not considering other benefits). This is called the ‘break-even’ off-set price. The project with the lowest `break-even` off-set price is the most competitive in financial terms, but not

Table 1 Cost-effectiveness of off-sets

	EUA or CER*	**My-Climate**	**Plan Vivo**	**Own project**
Off-set cost €/tCO2	14-28	25	10-18	>20
Types of projects	Alterna-tive energy	Mainly alternative energy	Agro-forestry; reforest-ation; protection	Agro-forestry
Certification	CDM	Gold Standard	Plan Vivo	Plan Vivo ?
Off-set uncertainty	Addition-ality	Addition-ality	Perman-ence	Perman-ence?
Econom. & livelih. benefits	Low	High	High	High?
Biodiversity co-benefits	Low	Medium	High	Higher?

necessarily the project providing the greatest welfare because other economic, social and biodiversity co-benefits have not been considered.

Table 1 shows that the most cost-effective carbon off-set alternative is direct purchase from the already established Plan Vivo project. The break-even carbon off-set price of an "own project" is higher depending on the area involved. Most of the costs of establishing and certifying a project are fixed and probably higher for an "own project" than an established Plan Vivo project such as Scolol Té.

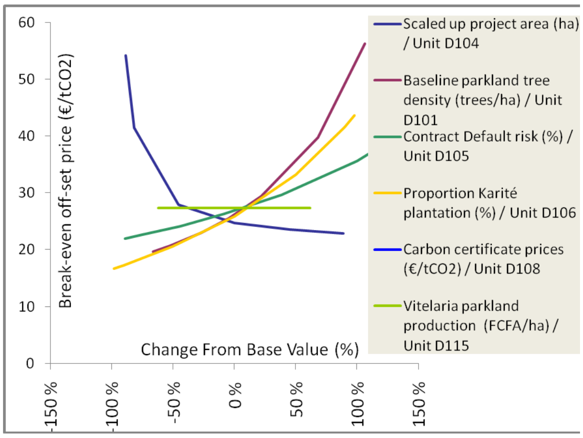

Figure 1. Range of carbon off-set prices required for project to break-even given % change from base value in key input variables

Figure 1 shows how sensitive the break-even off-set price is relative to project area, baseline parkland tree density, default risk, proportion of total cover under *V. paradoxa*. Break-even off-set price was most sensitive to project area (affecting costs/ha) and baseline tree density (affecting income/ha).

Small trees exposed to grazing.
Photo: David N. Barton

Figure 2 provides further detail of the relationship between project area and the break-even off-set price. We can see average costs flattening out for

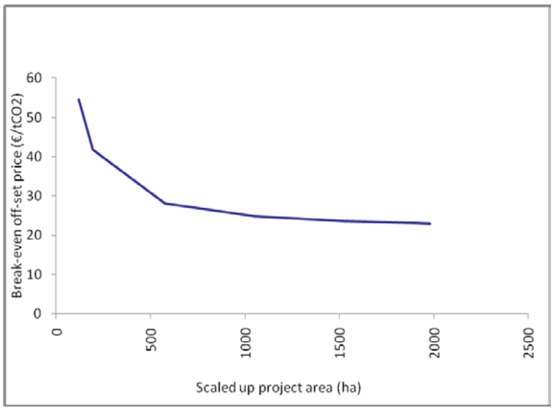

Figure 2. Break-even carbon off-set price determined by project area

projects larger than about 500 hectares.

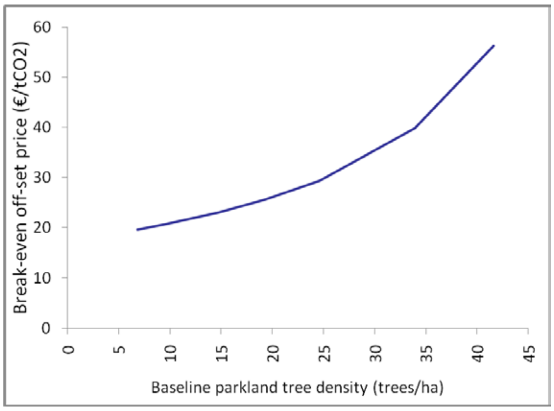

Figure 3. Break-even carbon off-set price determined by baseline parkland tree density

In the opposite sense, sensitivity analysis of the off-set price to baseline tree parkland density shows the additionality is greater when baseline density is lower. Lower initial density leads to greater additional carbon sequestration and net income from off-sets, leading to lower break-even prices (Figure 3). The model assumes no feedback effects, and this relationship is most valid for plantation within existing parklands where a target tree density has been established. For assisted natural regeneration of e.g *F. albida* we should expect lower regeneration density with lower baseline density of established trees. In that case the slope of the curve in Figure 3 could not be expected to be as steep as shown. Such feedback effects should be the subject of plot level experiments during a pilot phase.

Economic feasibility

We also conducted a sensitivity analysis for the economic feasibility of a scaled up project (Figure 4). Net present value is most sensitive to the carbon off-set price, project area and baseline parkland tree density.

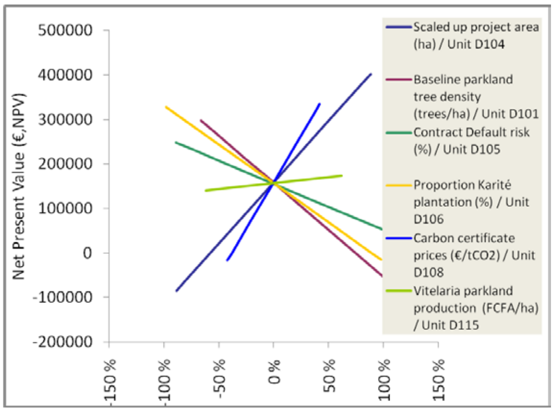

Figure 4. Economic feasibility of a carbon-off sets project given uncertainty in key input variables

With the simplifying assumptions of our analysis, the scaled up project has a positive economic net present value for project area more than about 450 hectares (Figure 5). Accounting for benefits to fodder and food security would bring the 'minimum economically feasible' project area down further. Coincidentally, most of the established Plan Vivo projects are larger than this.

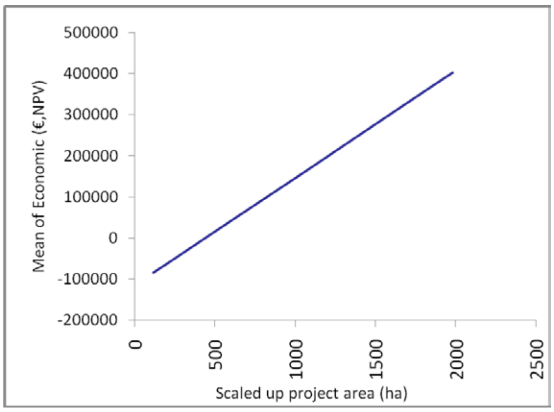

Figure 5. Economic feasibility of carbon-off sets given project area

Discussion

ANR project organization

Smektala *et al.* (2005) argue that the management unit ARN must work with is the 'community territory' around a village. At the same time the prime motivation for agroforestry stated by Samaké *et al.* (2008) was the desire to demarcate private lands and keep cattle out. A real organizational challenge should be expected in distributing the rights and responsibilities among farmers in a community with respect to the costs and benefits of regenerated trees.

We should state clearly here that the carbon off-set idea evaluated in this Technical Brief has not been discussed this far with communities. It is a desk study and as such a pre-feasibility assessment in terms of the project eligibility criteria specified by Plan Vivo (Appendix 2).

Community participation would need a close cooperation with the Millenium Village Project. A number of project coordination options need to be evaluated. While a project coordination office would normally be established, perhaps under the umbrella of MVP, local organizations would have to be formed to take charge of project implementation. Based on Peltier, Smektala and colleagues' experiences from other ANR projects a 'Service Communal de Suivi de l'Environnement (SCSE)' would be needed in participating municipalities, working as local project offices. This unit would employ project technical staff for monitoring, to be trained by the project. To assist the SCSE at the level of each village (roughy 500 inhabitants or 5000 hectares) so called 'Association Villageoise de Restauration de l'Environnement (AVRE)' would be needed. The AVRE would have a democratic structure of elected members of an office comprising a president, a secretary, treasurer and 4-8 members representing different social groups (old, young, women, men, cattle herders, farmers etc.). The MVPs existing committee for the environment may be a starting point for establishment of AVREs.

Given that the main cost of establishing an off-sets project is administrative/institutional, the cooperation between FunciTree, MVP and communities would be the most important criteria for determining the feasibility of a scaled up off-sets project.

Conclusions

The financial feasibility analysis shows that the most cost-effective carbon emissions off-set option for FunciTree is direct purchase of certificates from a Plan Vivo project. The economic analysis, including notably harvesting of fuelwood and some other tree products, implies that an off-sets project aimed at increasing parkland tree density would have positive returns for project sizes above about 450 hectares. This minimum feasible project area would be lower with a better economic accounting of parkland trees multi-functionality and multiple services.

There is therefore a case for initiating a detailed project design and feasibility evaluation. Following this general recommendation we think that:

- MVP would have to take a leading role in community consultation and project definition, with a timeline that allowed FunciTree to act as technical support
- to this effect, 'testing' AFS planned to take place in WP7 of FunciTree, might be moved forward for the specific AFS regarding carbon off-sets. FunciTree could then assist MVP with ecological and economic feasibility assessments of project criteria defined in discussion with communities.
- FunciTree could use its additional budget for offsets to assist MVP in providing the technical documentation needed for certification as a Plan Vivo project. While FunciTree could provide the necessary technical documentation with its own resources, we expect that validation and certification costs (roughly 2/3 of total set-up costs), might have to be borne by the MVP project for the off-sets project to become a reality
- Substantial organizational cost savings might be possible by bringing project coordination into the administration of MVP. Plan Vivo projects such as Scolol Té have high fixed costs which could be reduced by up to 50% according to Torres et al. 2010.

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Appendix 1 – benefit-cost analysis assumptions

Uncertain parameters:

Baseline parkland tree density (trees/ha): 20 Gamma distribution (90% confidence of 10-35 trees/ha)
Scaled up project area (ha): 1050 (uniform distribution 100-2000 ha). (450 ha is roughly break-even size in economic analysis)
Contract Default risk (%): 20% (triangular distribution (min.0, mode 10%, max. 50%)
Proportion *V. paradoxa* plantation (%): 50% (uniform distribution min. 0% – max. 100%)
Carbon certificate prices (€/tCO2): 17,5 (uniform distribution min.10 - max. 25)
Seasonal net returns to *V. paradoxa* parklands (FCFA/ha): 6070 (uniform distribution min. 2244 - max. 9900) (2010 prices) (Boffa et al. 1999)

Selected fixed parameters

Stored carbon *V. paradoxa* stand (31 trees/ha): 5046 kg/ha (Peltier et al. 2007)
Sustainable harvested carbon *V. paradoxa*: 399 kg/ha yr (Peltier et al. 2007)
Stored carbon *F. albida* stand(12 trees/ha): 4200 kg/ha (Smektala et al. 2005)
Sustainable harvested carbon *F. albida*: 1167 kg/ha yr (Smektala et al. 2005).

Target tree density mature stand: 60 trees/ha
Seedling survival rate (first year): 75%
Sapling mortality rate grazing (years 1-3): 20%
Tree selection/thinning (year 10): 50%
=>Required seedling density (first year): 200/ha

Field-level monitoring costs ($/ha yr): 20 (Bauer et al 2005 in Torres et al 2010)

Compensation to farmers for Assisted Natural Regeneration: 200 FCFA/sapling (yr.1), 100 FCFA/sapling (yrs2-3)
V. paradoxa sapling cost: 1000 FCFA/sapling
Fuelwood price: 50 FCFA/kg (Ségou, Sept.2010)
F. albida impact on crop yields at farm scale: +11-17% (assumed negligeable) (Oliver et al. 1996)

Labour cost ratio Mali/Mexico: 20% (conversion of project office administration costs)
Exchange rates: 656 FCFA/€; 0,739 €/$
Discount rate: 8%

Additional Sensitivity analyses

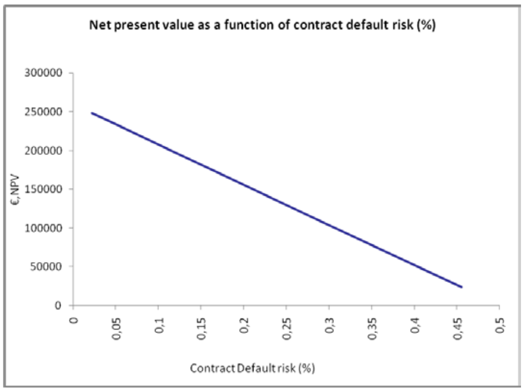

Figure A1. Sensitivity of NPV to risk of defaulting on contract

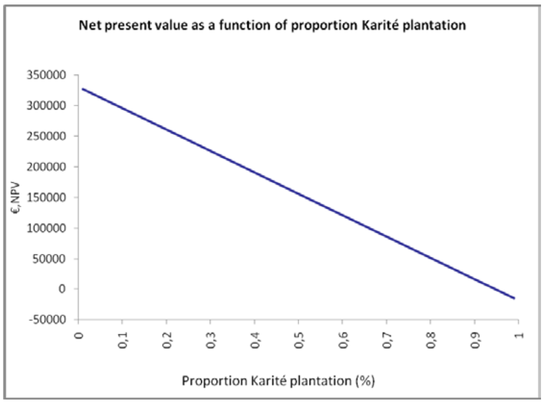

FIgure A2 Sensitivity of NPV to proportion of V.paradoxa in the project

Appendix 2 – Basic eligibility checklist for an envisaged Plan Vivo project (www.planvivo.org)

1. Start date

Projects will typically use the Plan Vivo Standards from the outset. However, it is also possible for a project that is already operational to become an approved Plan Vivo Project provided it can meet the Plan Vivo Standards. No retroactive crediting is possible for activities already implemented.

2. Project participants

2.1. Producers

- Must be small-scale farmers, land-users or forest dwellers in developing countries with recognized land tenure or user rights (see below).
- Must be organised into cooperatives, associations, community-based organisations or other organisational forms able to contribute to the social and economic development of their members and communities and democratically controlled by the members.
- Must be able to use existing forest/ woodland or other land for project activities without undermining livelihood needs.
- Must have a registered Plan Vivo for their own piece of land or be part of a group with a Plan Vivo for a piece of community-owned or managed land. Producers should not be structurally dependent on permanent hired labour, and should manage their land mainly with their own and their family's labour force.

2.2. Project coordinators

- Must have a strong in-country presence and the respect and experience required to work effectively with local communities and partners.
- Must be focused and have the organisational capability and an ability to mobilise the necessary resources to develop the project.
- Must have the capability to negotiate and deal with government, local organisations & institutions, and buyers of ecosystem services
- Must have the ability to mobilise and train participants, implement and monitor project activities, carry out technical functions.
- Must recognise that the decision of producers to participate in project activities is entirely voluntary.
- Must recognise that producers own the carbon benefits of the project activities they choose to undertake.
- Must ensure that the PES producers receive are fair and equitable and that payments are made in a transparent and traceable manner.

3. Land tenure/ use rights

- Must be secure (land tenure or use rights) so that there can be clear ownership, traceability and accountability for carbon reduction or sequestration benefits.

4. Project activities

- Must enable communities to plan and take control of their resources in a sustainable way that promotes rural livelihoods and other environmental and social co-benefits.
- Must be eligible to receive payments for ecosystem services (PES) under the Plan Vivo System, i.e.
  - Afforestation / reforestation
  - Agroforestry
  - Forest restoration
  - Avoided deforestation
- Must be additional, not liable to cause leakage, and provide foundations for permanence, as described in the Plan Vivo Standards.
- Must involve the planting and/or promote the restoration or protection of native or naturalised tree species. The use of naturalised (i.e. non-invasive) species is acceptable only where such species can be shown to have compelling livelihood benefits and:
  1. Communities have clearly expressed a wish to use such species;
  2. The areas involved are not in immediate proximity to conservation areas or likely to have any significant negative effect on biodiversity;
  3. The activity is still additional;
  4. The activity will have no harmful effects on the water-table.
- Must encourage the development of local capacity and minimise dependency on external support.

5. Project landscape

- Must have clear boundaries that can be mapped.
- Must be suited to the replication and expansion of project activities into new areas.

6. Expansion ambitions

- Must be based on a commitment to initiate activities on a pilot basis, gaining experience, and identifying improvements (‘learning by doing’).
- Must be based on practical capabilities ‘on the ground’, not on high level targets imposed fromabove (‘plant x no. of trees in y years’).

Functional Diversity:
An ecological framework for sustainable and adaptable agro-forestry systems in landscapes of semi-arid ecoregions.

Based on the principles of functional ecology, FUNCiTREE addresses the provision of multiple services of silvopastoral systems (SPS) in semi-arid regions in Africa and Central America. FUNCiTREE aims to provide farmers in the regions with a portfolio of regionally suitable tree species that are capable of providing multiple services. The project integrates theories and concepts from agroforestry and ecological science and will provide a scientifically based model for the design of modernized SPS.

NINA (Norway): Research emphasizing the interaction between human society, natural resources and biodiversity

CATIE (Costa Rica): Interdisciplinary research on agricultural sustainability, environmental protection and poverty eradication

WUR (The Netherlands): Internationally leading university in agricultural, environmental, and climate research

CSIC (Spain): Research in plant and animal ecology, biodiversity conservation, desertification, and soil science

CIRAD (France): Agricultural research centre working for international sustainable development.

ISRA (Senegal): Priority research areas relate to agronomic, animal, forest and rural socio-economy

IER (Mali): The primary Malian research institution on agriculture