Allocating Capital for Maximum Impact in Africa’s Plantation Forestry Sector

White paper

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PURPOSE

Amid unsustainable utilization of its forestry resources and inadequate new investments in plantations and manufacturing capacity, Africa faces a growing gap in wood supply and an associated growing trade deficit in wood products. Given these circumstances, it is essential that the limited capital available for developing Africa's commercial forestry sector be allocated to projects with the highest productive use and greatest development impact. The capital allocation function is complicated by the fact that essential information is often unavailable or unreliable.

This report compares three alternative plantation investment approaches aimed at increasing the sustainable supply of timber in Africa. Given the scarcity of long-term capital available in Africa and the urgent and growing need for more wood, this analysis endeavors both to summarize the major forestry investment approaches and to estimate the relative impact of each dollar spent on the various project types in terms of financial, social and environmental returns.

THE AUTHORS

This report is the product of collaboration between Indufor Oy and Criterion Africa Partners ("CAP"), both firms with extensive experience working in the African forestry sector. Indufor focused primarily on the smallholder plantation forestry analysis.

Indufor Oy is an independent international consulting company with its head office in Helsinki, Finland and regional offices in Auckland, New Zealand; Melbourne, Australia; and Washington, D.C., the United States. Indufor leads forestry know-how in Africa with an extensive track record of various types of assignments related to forests and forest industries across the continent. These assignments have comprised due-diligence, market studies, asset valuations, business planning, and operational improvements. In addition, Indufor has been involved in public policy and institutional development, as well as improvement of social and environmental infrastructure.

Criterion Africa Partners ("CAP") is a newly formed investment management firm owned and managed by the team of professionals that manages GEF's African Sustainable Forestry Fund ("ASFF"). The CAP team has invested in Sub-Saharan Africa's forestry sector since 2001 and oversees a portfolio of approximately 200,000 hectares of plantation and related conservation lands as well as 550,000 hectares of tropical forest concessions. All forestry areas are managed to the stringent requirements of the Forest Stewardship Council and each forestry area is integrated with downstream manufacturing facilities. ASFF's portfolio companies produce approximately 2 million cubic meters of harvested logs each year that are utilized to manufacture a broad range of downstream forest products including lumber, utility poles, composite panels, plywood, and biomass energy. CAP's portfolio is the largest source of industrial roundwood for African end markets.

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ABBREVIATIONS

CAP	Criterion Africa Partners
CO_2	Carbon dioxide
DFI	Development Finance Institution
FDI	Foreign Direct Investment
FSC	Forest Stewardship Council
GEF	Global Environment Fund
GHG	Greenhouse Gas
ha	Hectare(s)
HFO	Heavy Fuel Oil
IRR	Internal Rate of Return
IRW	Industrial Roundwood
m^3	Cubic meter(s)
p.a.	per year
PPP	Public Private Partenrship
SPGS	Sawlog Production Grant Scheme (Uganda)
SSA	Sub-Saharan Africa
tCO_2	tonnes of carbon dioxide (1,000 kg of carbon dioxide)
TGA	Tree Growers' Association
USD	United States Dollar

EXECUTIVE SUMMARY

Africa is facing a looming shortage of wood and wood products which will drive up domestic prices and imports, increase the degradation and deforestation of natural woodlands, and hamper sustainable economic development.

The continent currently consumes the equivalent of around 100 million m^3/year of round logs, in the form of lumber, wooden panels, utility poles, building materials, and other value added wood products. Of this demand, only a quarter is currently supplied by Africa's 4 million hectares of plantations; the balance comes from natural forests and imports. The plantation area is relatively stagnant, with only around 10,000 hectares of new plantations established per year. Meanwhile, demand for wood products is growing steadily at 5-7% per year, driven by population growth and urbanization throughout Africa. Between 2001 and 2015, Africa's imports of forest products grew at 9% p.a., while exports grew at only 5% p.a., and Africa turned a net importer of solid wood products in 2006. The trade deficit in forest products currently approaches $2 billion per year and is expected to continue to grow at a rate of more than $100 million annually. In order to meet the growth in demand for wood, over 300,000 new hectares would need to be established each year based on an assumed growth rate of 18 m^3/ha/year. Yet, both international and domestic investment in Africa's forestry sector has only been a small fraction of that seen in other regions.

In light of these dynamics, there is an urgent need for more investment in the African forestry sector, from plantation establishment and management to downstream processing and distribution. Given the relative shortage of capital currently available in the sector, it is imperative that investments are made strategically to maximize their cost-effectiveness and their positive development impacts.

This paper evaluates the relative cost and development impact of past and projected investments in existing plantation forestry projects in Africa. The projects are divided into three categories: (i) **greenfield plantations**, where new industrial plantations are established on "bare land"; (ii) **brownfield plantations**, where existing industrial plantations are acquired and rehabilitated to improve their growth potential; and (iii) **smallholder plantations**, which are small scale forestry investments, typically community based. The analysis is based on 22 different plantation projects in 10 separate countries, encompassing the planned establishment and management of 453,000 hectares, of which 250,000 hectares were already planted or rehabilitated by 2015 at a cost of $824 million.

The analysis includes a heterogeneous group of plantations, encompassing different species and silvicultural regimes. As such, the results should be interpreted cautiously. However, since the plantations included in the study represent a large share of the plantation investment made in SSA during the last two decades and we report on averages for each category, we believe the results provide valuable information for stakeholders involved in the African forestry space. The analysis finds that greenfield projects have been by far the most expensive to date on a per-hectare basis, with an average cash cost of $5,700 per hectare. The acquisition and rehabilitation of brownfield plantations is considerably cheaper, at under $1,700 per hectare. Meanwhile, small-holder establishment is the most cost effective on a per hectare basis, at $1,100 per hectare. The cost of capital is also an important factor in all cases, nearly doubling the overall cost for brownfield plantations, and more than doubling the overall cost for greenfield and small-holder plantations, when assuming a 12% cost of capital. Greenfield plantations are more heavily impacted by the cost of capital due to the long time involved to reach maturity.

On a woodflow basis, the results are similar. The greenfield projects in our sample set cost $308 per cubic meter of annual growth capacity, while the cost for smallholder projects was $59 per cubic meter of annual growth. Brownfield projects again were in the middle, with a cost of $113 per incremental cubic meter of annual growth. The analysis necessarily relies on a number of simplifying assumptions, and limitations in the analysis and conclusions are discussed in the paper.

The Authors conclude that the differences in project expenditures are driven by four main cost factors: land, infrastructure, overheads, and capital. At one end of the scale, smallholders typically plant on a portion of land they already own, take advantage of public infrastructure, have limited overheads, and are less impacted by cost of capital due their lower overall capital demand and their relatively shorter rotations. Greenfield projects, at the other end of the scale, usually face very high (and often higher than expected) costs in all four areas.

From a development perspective, forestry provides jobs and economic development in rural regions of Africa. The benchmarking exercise finds similar numbers of jobs per hectare for greenfield and brownfield projects, though the number of employees per invested dollar is of course lower for greenfield projects due to the higher cost per planted hectare. Smallholder projects typically rely on own labor and informal work, therefore creating fewer formal, full-time-equivalent wage-earning jobs, but arguably building wealth for a larger number of people over the same area.

Forestry has well-known climate impacts, which are of key interest to many development-oriented investors. The paper analyzes the climate impacts of the three strategies, based on a hypothetical investment program of $100 million spread over ten years. In light of the major role that household energy plays in the African landscape—consuming 600 million m^3 annually, leading to major degradation of African woodlands—the Authors also consider three additional climate interventions: (i) producing biomass steam for industrial use; (ii) producing charcoal using more efficient production methods; and (iii) distribution of more efficient cooking stoves at the household level.

Intuitively, one might expect greenfield plantation establishment to be the most effective of the three plantation strategies from a climate perspective, given that trees are planted where there previously were none. However, interventions in brownfield plantations to improve productivity and replant unplanted areas can also increase the overall standing biomass. Although the incremental volume may be less for brownfield investments, the analysis shows that the cost per incremental ton of CO_2 for brownfield (\$7/ton CO_2) is less than greenfield (\$15/ton CO_2) due to the high cost of greenfield plantations. Smallholder plantations (\$3/ton CO_2) provide the most cost-effective of the three forestry strategies to increase CO_2 sequestration due to the lower establishment cost.

From a climate perspective, biomass energy applications may offer a more cost-effective intervention than industrial plantations. Biomass steam boilers that replace heavy fuel oil (HFO) as a fuel source offset emissions at a cost of around \$5/ton CO_2, and can provide a commercial rate of investment return. Efficient charcoal kilns can produce the same amount of charcoal with about 60% less wood, offsetting emissions at a cost of under \$4/ton CO_2. And financing more efficient household stoves can also have a major climate benefit, also at a cost of roughly \$4/ton CO_2.

In addition to variations in their cost efficiency and development effectiveness, the strategies and interventions explored in this paper also vary in the expected financial returns on capital. Some will provide commercial returns for international investors, while others are more donor based or offer untested financing models. This suggests that different actors—commercial investors, development finance institutions, local governments and communities, multilateral donors, and others—will play important roles across the value chain. By recognizing their key contributions to the broader landscape of African forestry and coordinating their interventions where appropriate, the impact for each individual actor has the potential to be significantly higher.

Keeping in mind that investments are needed for each of the three plantation categories, this paper makes a number of observations and recommendations for the sector, based on the results of the cost benchmarking exercise:

Greenfield plantations are relatively expensive to establish, and thus face barriers to securing commercial financing. However, Africa urgently needs more plantation areas, and the existing greenfield plantations which have been established by pioneering entrepreneurs and investors will be critical sources of future wood supply. These projects should be supported by developmental financiers and regional and international policymakers to enable them to succeed and thrive. They will form the anchors of future plantation development, both by commercial companies and smallholders.

Brownfield plantations offer underappreciated potential to increase the wood supply to Africa through better management and increased productivity. Many brownfield plantations are currently managed by governments, and often producing far below their biological potential. Investments in brownfield plantations can be cost effective and lead to significant economic development and climate benefits. Developmental institutions and donors should encourage forest sector reform in Africa, including helping governments to undertake well-structured privatization processes that encourage responsible investors to acquire and manage these forest assets.

Smallholder plantations can be established cost effectively, have high positive developmental and climate impacts, and, in the right circumstances, have the potential to be quickly scaled while avoiding many of the local and international politics about land that have hampered commercial plantation development. Smallholder development to date has largely been donor financed, and continued subsidies and technical support will be important to assist farmers to produce the quality logs that will bring them the best value. It should be noted that smallholder plantations schemes often fail when such programs are not developed in conjunction with nearby larger, commercial plantations. Larger plantations often have the harvesting, transport and value-adding processing equipment, technical know-how and channels into the market that allow smallholders to achieve good prices for their harvests. Tree growers' associations may also provide an effective model for both financiers and markets to engage with smallholders.

1. BACKGROUND: GROWING SUPPLY/DEMAND IMBALANCE FOR BASIC FOREST PRODUCTS IN AFRICA

In 2013, Global Environment Fund ("GEF") published a white paper titled "Africa will import—not export—wood." The widely-read paper, drawing on trade statistics and other research, debunked the conventional wisdom that Africa would be the next source of fiber to meet growing global demand. In fact, Africa does not have enough wood to meet its own steadily growing demand for building products and wood energy, a situation that is readily apparent when reviewing international trade statistics. Africa became a net importer of wood products in 2006, and the trade balance has worsened by an average of more than $100 million per year during the period 2001-2015, as domestic demand grows steadily and wood supply remains stagnant[1].

GEF's original analysis of supply and demand for forest products in Africa has been updated with additional analysis and current trade statistics in a soon-to-be-released white paper, provisionally titled "Africa Will Import—Not Export—Wood: Part II." The key conclusions are consistent with the earlier white paper, including:

- The estimated total industrial round wood ("IRW") demand in Sub-Saharan Africa ("SSA") is about 100 million m^3/year, only about one-third of which is supplied from forest plantations. The balance comes from natural forests or imports. Driven by overall economic growth, urbanization, and resultant construction growth, the demand for industrial wood products in Africa, and particularly building materials, is expected to grow at an estimated rate of 5-7% per year.

- By 2020, SSA is expected to import in excess of USD 2 billion worth of basic forest products, some of which could be produced locally.

- Africa's industrial plantations, totaling some 4 million hectares, often suffer from unsustainable management. Meanwhile, only about 10,000 hectares of additional industrial plantations are established annually. In fact, the degrading of the existing plantation stock is running at a significantly higher rate than the meager 0.25% yearly increase in the plantation area from new industrial greenfield establishments. Africa's natural forests have also been exploited on an unsustainable basis, suggesting that the supply of wood from natural sources will become scarcer and more expensive over time, a trend that can already be observed in local wood markets.

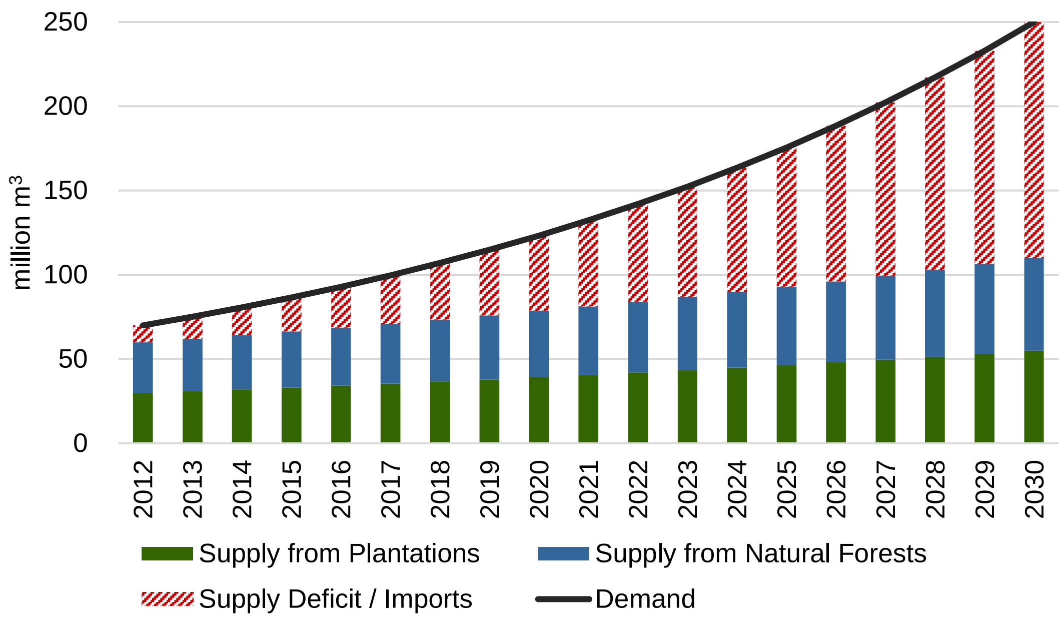
[1] Source of trade statistics: International Trade Center, Geneva Switzerland, 2017. For more details on African trade in wood and solid wood products, see "Africa Will Import—Not Export Wood: Part II", a forthcoming White Paper.

- The Authors estimate that the total annual harvest from Africa's 4 million hectares of industrial plantations is below 40 million m^3 per year, reflecting an overall productivity of less than 10 m^3 per hectare per year. Considering that about one-half (20 million m^3/year) is from the mostly well-managed 1.4 million hectares in South Africa and Swaziland, the productivity of the industrial plantations elsewhere in Sub-Saharan Africa is on average only 7 m^3 per hectare per year, far below the biological potential of the plantation sites.

- The demand for fuelwood for household energy and cooking is a major driver of degradation in Africa, with annual consumption of over 600 million m^3, representing a continental energy crisis.

Figure 1.1 illustrates the demand-supply dynamics for industrial round wood ("IRW") and demonstrates that a supply deficit has indeed already developed and is projected to grow. Factoring in that about two-thirds of the 20 million m^3 harvested annually in South Africa is exported, mostly in the form of pulp by Mondi and Sappi, we estimate that the wood supply from plantations to cover African needs is below 30 million m^3, covering only about one-quarter of the current demand for IRW.

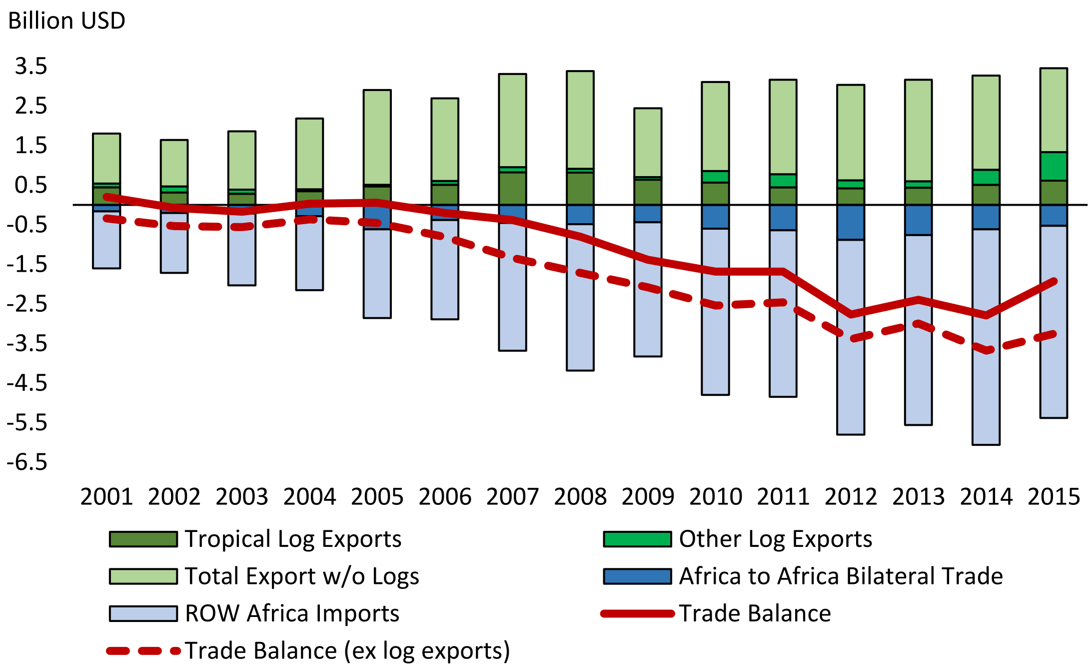
Figure 1.1 Projected Demand and Supply Industrial Roundwood in Africa (million m^3)



Source: Food and Agricultural Organization; CAP and Indufor Estimates

Figure 1.2 summarizes African trade in wood products for the past 15 years. Imports grew at over 9% per year during this time, while exports increased at less than 5% per year (4% per year if we exclude log exports), resulting in a trade deficit of $1.9 billion in 2015 ($3.3 billion if we exclude log exports). Viewed in the context of the total global trade in solid wood products, SSA has recorded a growth rate of 11% in imports of wood products from 2001 to 2015, higher than any other region. Overall, Africa's imports as a share of the total global trade in solid wood has increased from 2% in 2001 to about 3.8% currently. Amid population growth and rapid urbanization, the Authors expect Africa's rapid growth in imports of solid wood products to continue and the share of the global trade along with it.

Figure 1.2 African Solid Wood Trade 2001-2015: Export, Import and Trade Balance



Source: International Trade Center, Geneva Switzerland

1.1 Investments into SSA Forestry Sector since 2000

The growing supply deficit for industrial round wood in Africa points to an urgent need for investment in Africa's forestry sector to increase the total planted area (greenfield), to improve the productivity of existing plantations (brownfield), and for industrial developments along the value chain.

Excluding South Africa, CAP estimates (based on bottom-up analysis of all known projects) that the total foreign direct investment ("FDI") into the forestry sector in SSA was about $1.5 billion between 2000 and 2015 (i.e., about $100 million per year), of which about $500 million was from Development Finance Institutions (DFIs).

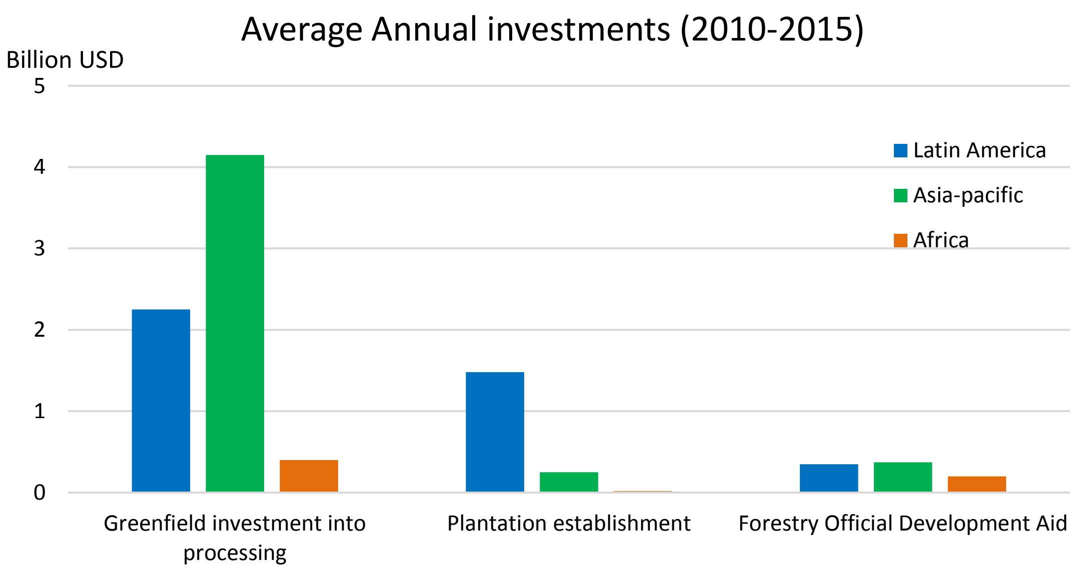
However, the FDI from commercial sources appears to have dried up in the last five years due to a combination of the 2008 financial crisis, limited investor appetite for African risk in general, the lower expectations related to carbon-motivated financing, and discouragement from failing forestry projects in Africa. As a result, the DFIs often represent the only source of significant capital for forestry projects in SSA, outside South Africa.

While well-established forestry groups in South Africa have continued to invest during the past 15 years, many small and medium sized forestry groups and family operations have struggled to maintain the productivity of their assets, leaving good scope for productivity improvements, even in South Africa.

This lack of investment in sustainable forest management is mirrored by a lack of investment in downstream manufacturing activities. Indufor estimates that investments in wood processing in Africa between 2010 and 2015 averaged only about $50 million per year. A similarly meagre level of investment (excluding Official Development Aid for forestry) was made in plantation resources.

The graph below (Figure 1.3) summarizes investments into forestry and manufacturing for Africa, Latin America and Asia for the five-year period 2010-2015. Note that investments for both plantation establishment and in manufacturing in Asia-Pacific and Latin America are 8-10 times higher than for Africa.

Figure 1.3 Investing in Forestry and Wood Processing



Source: Economic Commission for Latin America and the Caribbean (ECLAC), fDi Markets, Indufor Plantation Databank, OECD CRS.

Thus, recent and current investments in African forestry and/or downstream processing are only a fraction of what is needed to meet Africa's growing demand for wood and forest products. While there may be sufficient capacity of small unregulated sawmills—often operating on an unsustainable basis—the rapidly growing import of higher value solid wood products suggests there is a need and an opportunity for investing in downstream manufacturing. Moreover, recovery rates in wood processing in SSA are often very low due to inefficient and outdated equipment and practices. This is consistent with the conclusions McKinsey's drew in a recent comprehensive report on Africa, where they are highlighting the downstream manufacturing opportunities across many sectors, created by the absence of local manufacturing to meet growing demand from the rapid urbanization[2].

Given the relative shortage of investment capital available to the African forestry sector, the objective of this white paper is to provide guidance to commercial and developmental investors and donors about the relative effectiveness of plantation investment strategies, as measured by the ratio of investment cost to increased output of industrial round wood.

Although this analysis focuses primarily on tree plantations, it is important to recognize that the lack of investment in downstream processing also has a negative impact on the return on investments in plantation resources. Specifically, if the wood-flow from plantations (greenfield and/or brownfield) is directed towards lower value end uses, both the cash-flow from the plantations and the value of the plantation will suffer accordingly.

Thus, both from a developmental and commercial vantage point, it is critical that the allocation of capital consider the entire forest product value-chain. Considering the scarcity of capital, investors should prioritize (a) cost effective investments in plantations aimed to increase the sustainable supply of timber as well as (b) associated downstream processing to meet local demand while helping to put maximum value back "on the stump". Downstream investments are often required to ensure the full impact of investments in the plantation resource.

[2] "Lions on the Move: Part II", McKinsey Global Institute (September 2016).

2. METHODOLOGY FOR BENCHMARKING COSTS AND OUTPUTS OF THREE PLANTATION INVESTMENT APPROACHES

The primary objective of this white paper is to examine three different ways to invest in plantation forestry in Sub-Saharan Africa[3], analyzing the typical financial profile of each along with their relative merits in delivering financial and developmental returns. This chapter outlines our methodology and data sources, and the following chapters outline the results and conclusions.

2.1 Three Approaches to Timber Investing in Africa: Background and Description

We have divided investments into African industrial plantations into the following three complementary categories:

1. "***Greenfield***": Develop new greenfield plantations by acquiring or leasing property to establish plantations in areas that were not previously planted to timberlands.

2. "***Brownfield***": Rehabilitate existing plantations—areas gazetted to forestry, but producing well below their potential. With the low average productivity of most plantations outside South Africa, a significant area of standing trees could fit into this category. For the purpose of this analysis we have only considered plantations where at least one-third of the plantation is unplanted and/or the overall silviculture regime has been dramatically changed to increase the productivity of the resource.

3. ***"Smallholder"***: These are small-scale forestry investments, typically community-based. It should be emphasized that many of the smallholder programs in Africa today have been based on donor funding which offers technical assistance and planting subsidies. The smallholder model is included in our analysis as we view smallholder forestry as a key component of increasing the overall wood supply in Africa. It remains untested whether there is an investment model by which outside investors can earn a financial return.

A detailed description of these three different plantation investment strategies, along with examples of each category, is provided in Appendix A.

[3] We note that apart from the three strategies we discuss in this paper, there is a fourth strategy possible for timber investing in Africa, which is to buy high-quality plantations that are already in sustainable rotation. Such a strategy is possible at scale only in South Africa, but given the focus of this paper on comparative investment strategies for the broader Sub-Saharan African region, is not examined here.

2.2 Data Set and Methodology for the Cost Benchmarking Analysis

The purpose of this cost benchmarking analysis is to compare the investment costs for three different categories of plantations in Africa, i.e., (i) greenfield, (ii) brownfield and (iii) community-based smallholder plantations. The focus is on total investment cost to acquire or establish the plantations until the plantation can be supported by internal cash flows. The investment cost can be understood as a cash cost plus an associated cost of capital. In turn, these investment costs will be compared with the productivity of the respective plantations to be able to assess the relative impact of the investments.

This analysis is based on 22 different plantation projects in 10 separate countries, across the three different categories, encompassing the establishment of 200,000 hectares of additional plantations from a total planted base of 250,000 hectares as of year-end 2015.[4] The total cash invested in the projects included in this analysis as of 2015 was about $824 million. The total area planted for these 22 plantations is targeted to increase to about 453,000 hectares and the cumulative investment cost is projected to reach nearly $1.42 billion at "completion". For all 22 projects, completion is defined as the time at which the respective plantations are in rotation, presumably yielding a significant positive cash flow.

The selection of projects included in the analysis was based on the availability of data. However, the sample size and analysis—in particular as it relates to greenfield projects—represents a large market share of plantation projects executed in SSA during the past 25 years. Accordingly, we believe the results of this cost benchmarking are representative.

This paper only reports the weighted averages for each of the three plantation investment categories. This will reduce the impact of peculiar cost structures for individual projects and strengthen the significance when comparing results between the three different groups. Perhaps most importantly, the data for the individual plantation projects are proprietary in nature; in this study no proprietary data has been published.

The report will focus on the total investment cost, including comments on the cost of capital, required to establish or acquire and rehabilitate the plantations. We have applied a nominal required rate of return of 12% for all the plantation projects to reflect a reasonable discount rate for SSA. Using a uniform rate for the cost of capital facilitates comparisons in terms of investment and development effectiveness. Moreover, since both commercial investors and the DFIs adhere to commercial

[4] The data for the greenfield and brownfield plantations were provided by CAP, while Indufor provided most of the data related to small-holders.

principles in their investment decisions, the inclusion of a cost of capital reflecting African risk-premiums better helps to distinguish between investment strategies in terms of their respective impact.

The analysis summarizes the status (costs and hectares planted) as of year-end 2015. These historical figures are based on actual cash costs, though in some cases where data are not available, the Authors have made estimates. In addition to the actual costs as of 2015, the analysis includes the projected costs and number of hectares to be planted at project completion. These forward-looking parameters are based on the respective promotors' own projections as far as possible, though in a few cases the authors have made adjustments based on other projects' cost structures, including African projects reported in the RISI 2012 Tree Farm Survey.

Several of the projects in our sample involve investments in associated industrial assets. Such industrial and downstream investments have been excluded from the analysis in order to be able to compare plantation investments only. Table 2.1 summarizes the projects included in the analysis: Slightly less than half of the total number are Greenfield investments, just over one-third are in the Brownfield set, and the Smallholder group makes up the smallest part of the total with four projects.

Table 2.1 Summary of Projects included in Cost Benchmarking Analysis

Type of Project	Number of Projects	Number of Countries	Number of Ha Planted 2015	Number of Ha Planted Maturity	2015 Ratio Of Completion
Greenfield	10	5	102,970	178,481	58%
Brownfield	8	4	103,331	129,691	80%
Smallholder	4	3	45,100	144,510	31%
Total	22	10	251,401	452,682	56%

Sources: Company Reports, CAP and Indufor Estimates

Table 2.2 summarizes investment value of the sample set. Greenfield projects dominate the sample set with over $1 billion (or two-thirds of the expected total investment) expected to be invested by the time the projects are complete. The brownfield projects we have analyzed are projected to need about $250 million by maturity, while approximately $160 million will go to the smallholder projects included in our sample. We believe the sample represents a very significant share of the total FDI into plantation forestry in SSA during the 25 year period of the study. The greenfield projects' dominance of the capital to be invested shows how important greenfield development has historically been to the African forestry sector in terms of attracting FDI.

Table 2.2 Summary of Amounts Invested ($ millions)

Type of Project	Number of Projects	Invested Year-End 2015	Projected Addition	Total at Completion	2015 Percent Completed
Greenfield	10	$617	$398	$1,015	61%
Brownfield	8	$159	$90	$249	64%
Smallholder	4	$48	$109	$156	31%
Total	**22**	$824	$596	$1,420	58%

Sources: Company Reports, CAP and Indufor Estimates

Table 2.3 illustrates that the projects in our analysis span a significant period of time, both until the present (end-2015) and into the near future. Looking at the greenfield projects, the first was begun in 1993, and we expect the last to be completed in 2026. With about 102,000 hectares planted until 2015, the greenfield set of projects represents an average planting rate of about 4,400 hectares per year. If project sponsors are to be believed, the rate of greenfield planting in Africa among those projects will accelerate to a little under 7,000 hectares per year as they aim to establish about 77,000 hectares more during the next 11 years. This will bring the average rate of replanting to about 5,500 hectares per year once the plantations are at full maturity.

Among the brownfield projects, which had about 103,000 hectares planted by the end of 2015, the average rate of establishment / rehabilitation is projected to be about 1,600 hectares per year until these projects are back in full rotation. This is because the projects that we have analyzed for this paper are on average 80% complete, as shown in Table 2.1. We note, of course, that the hectares established under the Brownfield projects do not represent new expansion of plantation land, but improvement of its productivity (e.g., replanting of temporarily unplanted and/or burnt areas).

Of similar vintage as the brownfield projects are the Smallholder projects, though they are the most ambitious group in terms of additional planting. Having until now established about 3,800 hectares a year, Smallholder project sponsors in our sample expect to plant about 6,300 hectares per year over the next decade or so. We note that these figures for smallholders are small in relation to not only what is needed, but also what actually taking place. For example, in a recent review plantations in Ethiopia, Indufor estimates that smallholders has established about 35,000 hectares per year this century.

Table 2.3 Summary of the Average Rate of Planting in Plantation Projects Analyzed

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Type of Project	No. of Years Analyzed		Ha Planted per Year		Average
	to 2015	to Maturity	to 2015	to Maturity	Rotation Age
Greenfield	23	34	4,477	5,249	16.5
Brownfield	11	27	n.a.	1,648	17.2
Smallholder	12	23	3,758	6,283	13.9

Sources: Company Reports, CAP and Indufor Estimates

3. RESULTS OF THE COST-BENCHMARKING EXERCISE

3.1 Investment Costs per Hectare

Table 3.1 summarizes the average historical cost per hectare for each of the three different plantation investment approaches as well as the estimated costs at completion. In addition to the cash cost for establishing or acquiring and rehabilitating the plantations, this analysis has estimated the cost of capital based on a 12% nominal discount rate.

Table 3.1 Investment Cost per Hectare of Greenfield, Brownfield, and Smallholder Plantations

Type of Project	Number of Projects	Mean Investment Cost per Ha			Cost of Capital as % of Total
		Cash Cost	Cost of Capital	Total Cost	
Greenfield	10	$5,684	$11,895	$17,579	68%
Brownfield	8	$1,659	$1,488	$3,147	47%
Smallholder	4	$1,082	$1,697	$2,779	57%

Sources: CAP and Indufor Calculations

As previously mentioned, the results show that the lowest cost strategy was the smallholder group with average cash cost of $1,082 per hectare and total costs of $2,779. Smallholder initiatives tend to benefit from lower overhead costs than commercial forestry projects, which has a significant impact on the per-hectare cost. It is also important to note that smallholder plantations have not yet demonstrated that they can produce the same quality and value of logs per hectare, due to more informal approaches to silviculture as well as, in many cases, harvesting before maturity to meet landowner cash needs.

On average, brownfield plantations showed cash costs of $1,659 per hectare and total costs of $3,147 per hectare. The cash cost is higher than smallholder plantations since commercial plantations face higher overheads, and in most case investors are also paying to acquire existing standing trees. The capital costs are significantly lower than greenfield projects in particular, due to both the shorter implementation period, and the internally generated cash flow from previously planted stands.

Greenfield establishment was, perhaps not surprisingly, the costliest of the three strategies with an average cash cost of $5,684 per hectare, and total costs of $17,579 per hectare including the cost of capital. There are a number of reasons for the higher cash cost per hectare observed for greenfield projects, including higher overhead costs in their initial years; implementation challenges; unproven site productivity; land acquisition costs; and infrastructure costs.

The high capital cost for greenfield projects is mainly a function of the long period before cash generation, combined with the high cost of capital for projects with a relatively high risk profile. This is especially true for species such as pine and teak which have rotation periods of more than twenty years in many cases.

3.2 Investment Costs per Additional m^3 Sustainable Woodflow

Analyzing and comparing plantation projects based only on the investment cost per hectare involves a number of limitations. One important shortcoming is that the cost per hectare does not take into account the productivity or future value of the plantations. In an effort to address the productivity issue, we have analyzed the plantation establishment cost in relation to the incremental sustainable harvest volume.

The volume of wood available to be harvested from a hectare depends on the average growth rate of the trees, as measured by the Mean Annual Increment ("MAI") in cubic meters per hectare per year, and the number of years between planting and harvest. When a plantation is in rotation, the annual harvest is approximately equal to the annual wood growth on the plantation, which can be estimated by multiplying the productive area of the plantation by the MAI.

For greenfield or smallholder plantations, where plantations are newly established on bare land, the full harvest volume can be attributed to the investment in the plantation. In our analysis, we have used the MAI as the proxy for woodflow, and divided the investment cost per hectare by the MAI to calculate the investment cost per additional cubic meter of wood available on the market each year.

For brownfield projects, where there was already an existing plantation resource before the current investors got involved, we have estimated the incremental volume per hectare per year, based on the expected improvements in MAI compared to the base case. As previously mentioned, we estimate the average productivity for all industrial plantations in SSA excluding South Africa to be only about 7 m^3 per hectare per year. In our sample set, the baseline productivity is estimated to be 13 m^3 per hectare per year. Thus, investments to improve the productivity of existing plantations are not only needed, but also offer good potential for value creation in the wider investable universe. There are a wide variety of improvements that can be made by new investors, such as replanting areas that have been neglected, improving genetic planting material, better management and silvicultural practices, more weeding, better fire control, and so on. It should be noted that, for simplicity, our analysis assumed that the improvements in MAI took effect immediately, when in fact changes in forest management take time and the results are not always immediately apparent.

Table 3.2 Investment Cost per Additional m^3 of Annual Woodflow

Type of Project	MAI (m3 per Ha per Year)			Mean Investment Cost per m3 Gained		
	Baseline	Maturity	Gain	Cash Cost	Capital Cost	Total Cost
Greenfield	0.0	18.5	18.5	$308	$644	$952
Brownfield	13.0	23.7	10.7	$113	$101	$214
Smallholder	0.00	18.4	18.4	$59	$92	$151

Source: CAP and Indufor Calculations

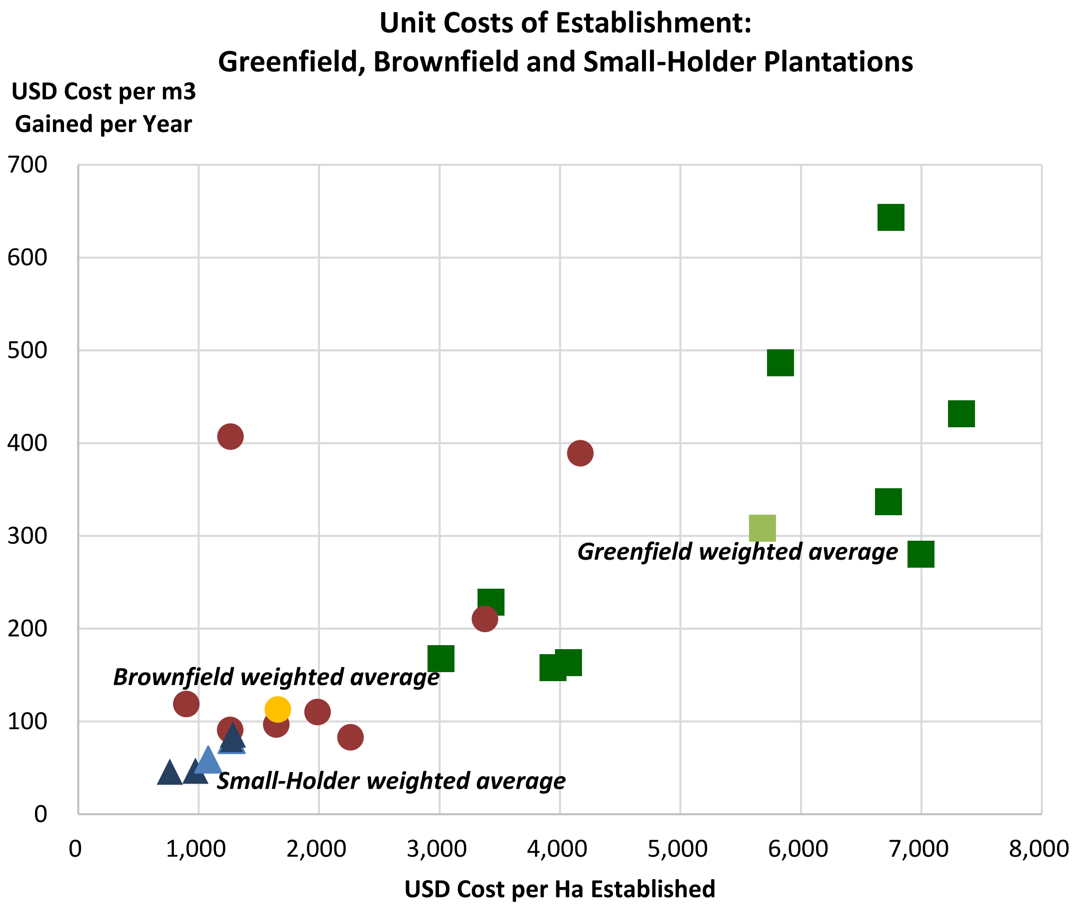
Here again we see that smallholder plantation establishment is the most cost-effective, requiring about $60 to establish the capacity to produce an additional cubic meter of timber per year that was not previously growing. However, it is important to remember that this analysis ignores the value or product mix of the final harvest, which also impacts the return on investment for all stakeholders involved. Typically, smallholder plantations are harvested earlier and yield lower proportions of high-value products. We note also, that the similar MAIs calculated for greenfield and smallholder plantations have emerged as a result of the data in our respective samples, where the greenfield plantations include teak projects, whose biological growth rate is naturally lower than the pine and eucalyptus in the smallholder sample. These smallholder projects – perhaps not coincidentally – happen to have been established in particularly biologically-productive areas.

Based on our sample set, we observe that the cost of producing incremental wood volume is nearly three times higher for greenfield ($308 in cash costs per annual cubic meter) than brownfield ($113 cash cost per annual cubic meter). The discrepancy widens even further when incorporating the cost of capital. This demonstrates that brownfield forestry investments can be a very cost effective means of increasing wood products available to local markets, provided that investors are able to increase the average growth rates of the plantation in line with the examples in our data set.

3.3 Summary of Results for Cost Benchmarking

Figure 3.1 plots the cumulative total cash cost for each of the 22 plantation projects in relation to the total number of hectares planted (x-axis) and the incremental annual sustainable harvest volume in m^3 (y-axis). The cost of establishing a sustainable harvest volume is in effect a proxy for the cost of establishing the capacity to grow one cubic meter of wood per year. While this proxy incorporates the productivity of the plantation, it does not reflect harvesting costs, operating costs or the value of the wood. As such, it should be used with caution. It is not, in any sense, a reflection of profit or returns. However, beyond the more simplistic measure of the cost per hectare to establish a plantation, this capacity cost proxy serves the purpose of factoring in the incremental productivity for respective plantations.

Figure 3.1 Volumes and Areas per USD Invested



Key:
Greenfield
Brownfield
Smallholder

Note: One defunct greenfield project that never established any land under trees is excluded from this chart, though its costs (which were low as the project was determined to be non-viable relatively shortly after conception) are factored into the weighted average costs of establishment
Source: CAP and Indufor Calculations; Company Reports

As the chart above shows, establishment of greenfield plantations has historically cost significantly more than brownfield and smallholder plantations in Africa. In this context, we note that the three greenfield projects in the chart with the lowest cost and highest productivity happen to be the youngest projects, with numbers based mostly on the promotors' projections.

While our sample of smallholder projects is limited to four, we note that they are all clustered together yielding both low plantation costs (below $1,400 per hectare) and high productivity from the investment (below $90/m3). Not surprisingly, our analysis suggests the developmental community should prioritize finding ways to catalyze more smallholder plantation development in Africa. However, it is also worth noting that there is an opportunity for commercial and impact investors to invest in projects where smallholder plantation development is somehow incorporated as a more or less central part of the business plan.

Reviewing and comparing each of the projects included in our analysis, we believe the following factors have driven the large cost differences between the three categories:

- Land: While the direct cost of the land (the lease payment) may be modest for the greenfield plantation projects, the sponsors often make considerable investments in the form of securing the land, Environmental Impact Assessment-related activities as well as continued outreach to the community. On the other hand, other than the alternative cost of the land (which typically is low), the cost of the land for smallholder plantations is essentially zero, since the farmers already occupy the land. For brownfield plantations the "implied cost of land" is also low (similar to lease payments paid by greenfield projects, but without the same extensive start-up costs) suggesting that there is a buyers' market for forestry assets in Africa.

- Infrastructure: Plantations require significant investments in roads and other infrastructure. Infrastructure is generally in place for brownfield projects, while it must be developed for greenfield plantations. Small-scale community based farmers often rely on public infrastructure and more labor-intensive ways of management and transportation. It is possible that at larger scale, infrastructure and logistics may become a constraint on smallholder plantation forestry.

- Overhead Costs: Smallholder forestry is by nature low on overhead costs. For Brownfield plantation projects overhead varies considerably, but to the extent the projects involves harvesting and commercial operations, the overhead can be partially paid for by cash-flow from operations. For greenfield plantations, overhead is capitalized as part of the establishment cost.

- Cost of Capital: With the high discount rates applicable to SSA, the cost of capital is very sensitive to the cash-flow time-line. Several of the ten greenfield projects in our analysis involved pine and teak, both based on rotation cycles of about 22 years. The cumulative cost of capital is, as expected, significantly lower on average for brownfield projects, both because the cash costs are lower to begin with and because the time-line to a positive cash-flow is often much shorter. The cumulative cost of capital for small-scale community based forestry is lowest since it is largely based on own labor and no cash cost for land.

3.4 Limitations of this Cost-Benchmarking Analysis

While we believe the results of our analysis are representative for projects currently being implemented, the focus on investment costs, including the cost of capital relative to each hectare established and each m^3 sustainable yield, has limitations. Below we will identify other important factors, which are not part of this analysis, including:

- The analysis presents only a partial picture of productivity, reporting on only volume and not value in addition. As such, it fails to capture the concept of productivity through grade improvement as well as improvement in the volume produced, as depicted by the MAI. For example, community-based plantations show very well in this analysis of establishment costs, but they would show less well when value is taken into account. Indufor, for instance, estimates that 90% of the wood-flow from the community-based plantations in Ethiopia will be used for relatively low value fuel-wood.[5] In a sense, the low establishment cost will go hand-in-hand with the low unit value of the output.

- Related to the above, we have not adjusted for differences in the future cash-flow streams due to differences in targeted downstream markets. For example, a teak plantation is likely to achieve a significantly higher average selling price than the output from a short-rotation plantation targeting lower value products such as biomass energy. On a similar note, wood markets in Africa are diverse: a pine grower in East Africa may well expect higher prices than a company operating in South Africa where competition and sawmilling efficiency is greater.

- The greenfield projects in the analysis were skewed somewhat towards long-rotation crops (pine and teak) compared with the brownfield projects and as such

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[5] Ethiopia Commercial Plantation Forest Industry Plan, prepared by Indufor for IFC/World Bank, July 2016.

were particularly negatively penalized by a long implementation cycle and the high African discount rate.

- Concerning Greenfield investments. The unit costs per hectare for new planting tend to decrease as the plantation project mature.

- While community-based plantations appear to be the lowest cost strategy, it is not apparent how they can be transformed readily into an investable asset class. Certainly without further (costly) lobbying and intricate project design, it is difficult for a commercial investor to take advantage of the insights presented here.

- Finally, the authors have made estimates where numbers were unavailable. We expect that this lack of precision will be smoothed out by having reported aggregate and average numbers across the different groups. We also take note that the samples are largely for projects that have survived and the impact on any of the groups of defunct enterprises has been ignored.

4. SOCIAL AND ENVIRONMENTAL IMPACTS

4.1 Employment Impact per Invested Dollar

As a social impact metric, we collected information on the number of jobs supported by each project and in Table 4.1, we report the mean and the range by category. For the purposes of this paper, we included both own employees and labor working for contractors in the field. The number of jobs depends on the scale of the project, and we have therefore standardized this measure to jobs per 100 hectares planted.

A note on the smallholder data set. Estimating job creation among this group is very difficult. Most of the time small woodlots are managed by the farmers themselves and outside labor is used in the rare cases where the farmer owners have extra cash on hand. External labor is mostly used by owners of larger land areas that also normally live outside the farm in large cities earning regular salaries – a common case in one of our smallholder projects. If the farmers do not have time or money to carry out plantation maintenance work, the work is often left undone resulting in poorer performance of the woodlot. In this analysis, therefore, we have attempted to estimate a proxy for a full-time-equivalent wage-earning job by calculating a unit of man-years required to establish and maintain a plantation over the establishment period. This estimate is based on observations in the smallholder projects included in this analysis.

We also give a measure of how many dollars are invested every year on average to create or to sustain a single job in each sample set. Conceptually, brownfield rehabilitation projects seemingly do not create new jobs where they previously did not exist, though the investments made to increase productivity (e.g., by planting additional areas, intensify silvicultural activities, etc.) often involve hiring more labor and staff. Moreover, brownfield investment often safeguard existing jobs.

With greenfield and smallholder investments, new jobs are created. It is important, however, even in the case of brownfield projects, to give attribution for those jobs to the commercial enterprise that pays for the labor. Unlike biological growth, which would occur in the plantation whether the enterprise was present or not, a defunct brownfield operation without a rejuvenating investment would not be able to sustain any jobs at all in the long run.

Table 4.1 Job-Creation Impact of Establishment Strategies

Type of Project	Number of Jobs per 100 Hectares Planted (end-2015)			Cash Invested per Year per Job Supported
	Mean	Minimum	Maximum	
Greenfield*	9.9	5.8	20.1	$4,371
Brownfield	8.3	5.0	12.5	$2,116
Smallholder	6.4	5.9	17.1	$4,494

Note: *Excluding one defunct Greenfield project with no employees
Sources: Company Reports; CAP and Indufor Calculations

In the case of job-creation, brownfield operations, appear to be more cost-effective in terms of new investment required than both greenfield and smallholder forestry. This is because brownfield projects' existing cash flows support the enterprise's running costs. In our sample, smallholder projects seemingly generate fewer full-time jobs than industrial plantations, and we surmise that it is due to the seasonal nature of tree cultivation in these schemes, and the fact that tree-farming is seldom the tree farmer's sole occupation. What we do not capture – because we cannot, due to data and methodology constraints – are measures such as wages, economic impact, or job quality, which would also be important to assess to better understand the social impact of these investments. However, we presume there is a strong link between the overall economic activity level (e.g., revenue) and the long-term ability of a company to pay wages.

4.2 Carbon Impact

The positive climate impacts of plantation forestry are well documented and are a key objective of many development oriented investors. Thus, as well as benchmarking the investment cost associated with three different forestry investment strategies, we have also assessed the magnitude of the carbon impact for each strategy. In comparing approaches, we assess the efficiency of the carbon impact achieved per invested dollar.

In addition to the three categories of plantations, we have included the carbon impact of the following three other types of investments: (i) biomass steam, (ii) sustainable charcoal production, and (iii) distribution of efficient cooking stoves at the household level. We included these categories because they all have a very high carbon impact and as such represent alternative approaches investors can take to achieve their carbon-reduction targets. That said, it is important to keep in mind that these six different "investment interventions" range from commercially attractive at one end to grant-based development aid at the other.

It is also worth noting that the three of the interventions involving equipment (biomass energy, charcoal, and cook stoves) target impact in terms of less waste and reduced demand, while the impact of the three plantation investment approaches contributes to higher supply of wood. With Africa consuming over 700 million m^3 wood per year, equal to more than 20% of the global consumption, it will be necessary to address both the fundamental demand and supply issues to combat the currently unsustainable trajectory. With scarce financial resources available, one objective of this paper is to encourage a debate on where grants and/or investments will have the highest impact.

4.2.1 A Quick Primer on the Link between Forestry and Carbon Impact

The forest product industry offers a unique opportunity to reduce the global carbon footprint and mitigate climate change, since forests play a central role in the global carbon cycle. Specifically:

- trees on average sequester 0.92 tCO_2, per m^3 of growth[6] and are a renewable resource;
- wood products retain carbon, acting as a "carbon sink" (causing a net reduction of atmospheric CO_2 concentration);
- wood products can be a substitute for more energy-intensive non-wood products (e.g. plastics or building materials), thereby contributing to avoided emissions; and
- when sustainably produced, wood and wood residues can be used as carbon-neutral biomass fuel, replacing fossil fuel.

The GHG profile of forestry projects generally consists of (a) sequestrations (in the forest), (b) emissions (along the value chain), and (c) avoided emissions (replacing fossil fuel with carbon-neutral biomass). The net GHG profile of any individual project is composed of a number of GHG positive and negative components, some of which are difficult to measure. However, typically the largest component of GHG impact for forestry projects is associated with the carbon sequestered by growing trees.

[6] Fourth Assessment Report (June 2007) by Intergovernmental Panel on Climate Change.

4.2.2 Methodology to Measure Carbon Impact per invested dollar

In order to compare the impact between the six different interventions, we have assumed an investment of $100 million for each group, spread out in 10 equal investments of $10 million per year. Since the carbon impact for the various investments will continue after year 10—and at different rates for each category of intervention—we have estimated the carbon impact for a 50-year period for each investment group.

The fundamental assumptions applied in the carbon impact analysis are as follows:

Plantation Development (Greenfield, Brownfield and Smallholders)

- The relevant results from the cost benchmarking analysis are applied. Specifically, we have used the group averages for the following parameters: (i) cost of establishment per hectare, (ii) incremental growth rates, and (iii) maturity profile (rotation age).
- Since the three different plantation approaches typically involve conversion from grassland and/or previously deforested or degraded land, this analysis will use the incremental growth rate as a proxy for the carbon impact.
- After the respective plantations have reached maturity, meaning the carbon stock in the plantation is stable, we have assumed 30% of the annual harvest from the plantations represents long term carbon storage in solid wood products and therefore reflects a continued annual carbon impact associated with the plantation investment. In theory, a sustainably managed plantation will produce a perpetual stream of wood, which can represent the raw material for wood products, and/or a source of renewable energy replacing fossil fuel.
- It's important to note that what matters most with regard to sequestering carbon in standing trees is the increase in average standing tree volume relative to the baseline. The incremental MAI of the plantation used in our carbon model serves as a proxy for increasing the productivity of the plantation and therefore the sustainable standing volume.
- With regard to evaluating smallholder plantations, one should also keep in mind that smallholder plantations tend to have a shorter rotation and relatively lower stocking (meaning lower standing volume of trees at maturity) and a lower proportion of final product ending up in solid wood products (thus less proportion of the annual harvest stores carbon in the long term). Therefore, this analysis may overstate the carbon benefits of smallholder forestry relative to commercial forestry, though we do still believe the carbon benefits of smallholder forestry to be very high.

Sustainable Charcoal

- The cost and capacity of the charcoal retort is based on a quote from a reputable supplier in South Africa.
- The average useful life of the retort and equipment is 15 years.
- The baseline avoided emission (from unsustainably produced charcoal in SSA) is 2.8 tCO_2 per 1.0 ton charcoal produced[7].
- Additional indirect impacts from reduced deforestation and degradation are not considered.

Biomass Steam

- The fundamental assumptions (i.e., total cost of installation, steam production and avoided emissions) are based on a recently implemented CAP biomass steam project in South Africa.
- 1.0 ton of Heavy Fuel Oil ("HFO") yields around 15 tons of steam depending the boiler efficiency.
- A $2 million investment in a biomass system delivers 8 tph of steam output.
- Such 8 tph biomass boiler typically runs for 8,000 hours per year, generating 64,000 tpa of steam.
- The equivalent steam output of HFO will require 4,267 tons of HFO (64,000/15).
- Burning 4,276 tons of HFO will emit 12,515 tpa of CO_2 (assuming 80% of the HFO is carbon and the carbon is converted to CO_2 using the relevant atomic mass figures, i.e. multiplying by 44/12).
- Therefore, each ton of HFO emits 2.93 tons of CO_2.
- The average useful life of the boiler and equipment is modeled as 30 years.
- Viewed over the full life-cycle of the $2m biomass system, the avoided emissions are estimated at 375,450 tCO_2, implying a carbon dividend on 1.0 tCO_2 for each $5.33 invested.

Efficient Cook Stoves

- The cost, adoption rates, and impact from the distribution of efficient cook stoves are based on experiences from cook stoves deployed in Malawi.[8]

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[7] http://www.perspectives.cc/typo3home/groups/15/DFID/Low_GHG_charcoal_production_Meth_justification_document.doc

[8] Parameters related to efficient cook stoves have been supplied by C-Quest Capital.

- The average useful life of the stoves is 7 years and the average annual rate of drop-off in usage is 10%.
- The baseline avoided emission is assumed to be 2.15 tCO_2 per cook stove per year.
- Additional indirect impacts from reduced deforestation and degradation (due to less usage of wood) are not considered and neither are the considerable health benefits of avoided indoor air pollution.

4.2.3 Results: The Carbon Impact for six different investments of $100 million

The two graphs below summarize the relative magnitude of the carbon impact for a $100 million investment in six different types of forestry-related activities over a 50-year period. The first graph illustrates the annual impact while the second graph summarizes the cumulative impact for the 50-year period.

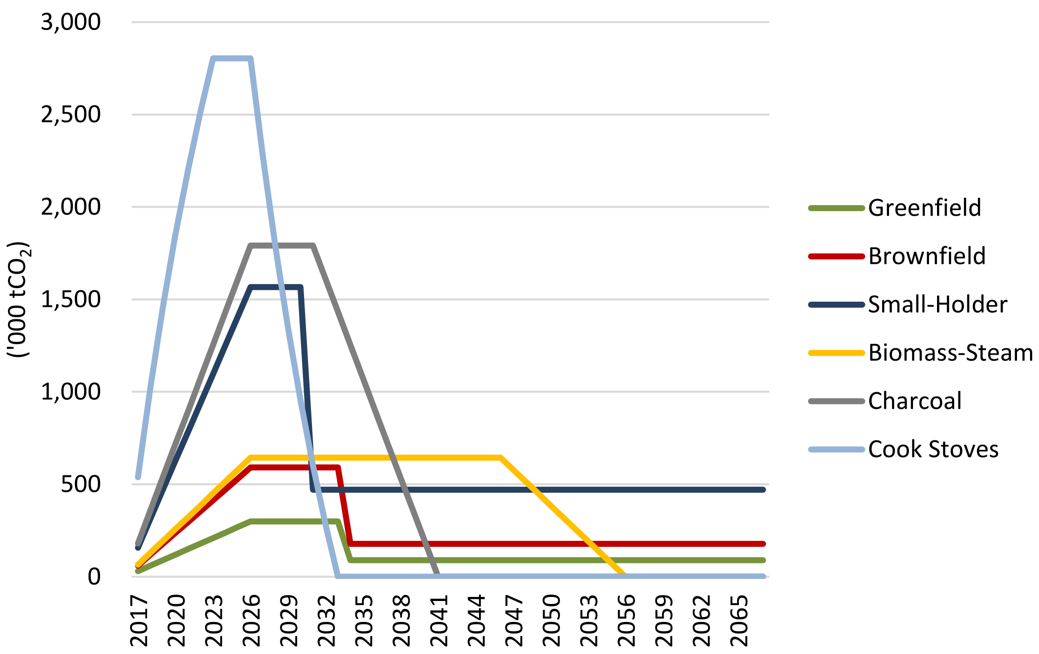
Before reviewing the results, it is important to remind the reader that the impacts for the three different categories of plantation developments are based on the group averages (costs and incremental growth rates) from our benchmarking analysis. Naturally, this factors in how large of an area one reasonably can expect to plant based on the historical experiences. With an average cost per hectare of $5,684 for greenfield vs. only about $1,082 per hectare for smallholder plantations, it is obvious that the carbon impact per invested dollar must be significantly higher for smallholders than greenfield.

Interestingly, the carbon impact per invested dollar of brownfield plantation investments is significantly higher than for greenfield, even though the incremental increase in growth rates for brownfield is lower than for greenfield (since brownfield has a baseline growth rate). Again, the key here is that the investment costs associated with acquiring and rehabilitating brownfield plantations is dramatically lower than greenfield for the reasons discussed above. From a GHG mitigation perspective, this implies that the cost of incremental growth (and by implication, carbon sequestration) is also lower than for greenfield development.

While the focus of this paper is mostly on investments in plantations, we recognize the magnitude of environmental destruction created by the unsustainable charcoal business across most of SSA as well as the combined health impacts (particularly to women and children) and environmental damage caused by traditional inefficient cooking stoves. As such, we wanted to include such investment interventions in our analysis to illustrate alternative high impact interventions related to the African forestry sector. Finally, we have included biomass steam (replacing Heavy Fuel Oil) on the basis that we see this as a viable commercial investment with high carbon impact.

In general, it is worth noting that the likely carbon impacts from distribution of efficient cooking stoves as well as production of sustainable charcoal are exceptionally high. This is because each of these interventions addresses different parts of the biggest issue facing the African forest resource, i.e., the heavy reliance of fuelwood in Africa[9]. Together with investments in biomass steam production, these interventions focus on equipment and processes to extract energy more sustainably from existing wood resources. However, unlike plantation developments, which sequester carbon until the plantation is mature, the carbon impact from these interventions can be measured in terms of avoided emissions relative to fossil fuels and/or less efficient utilization of wood for household energy.

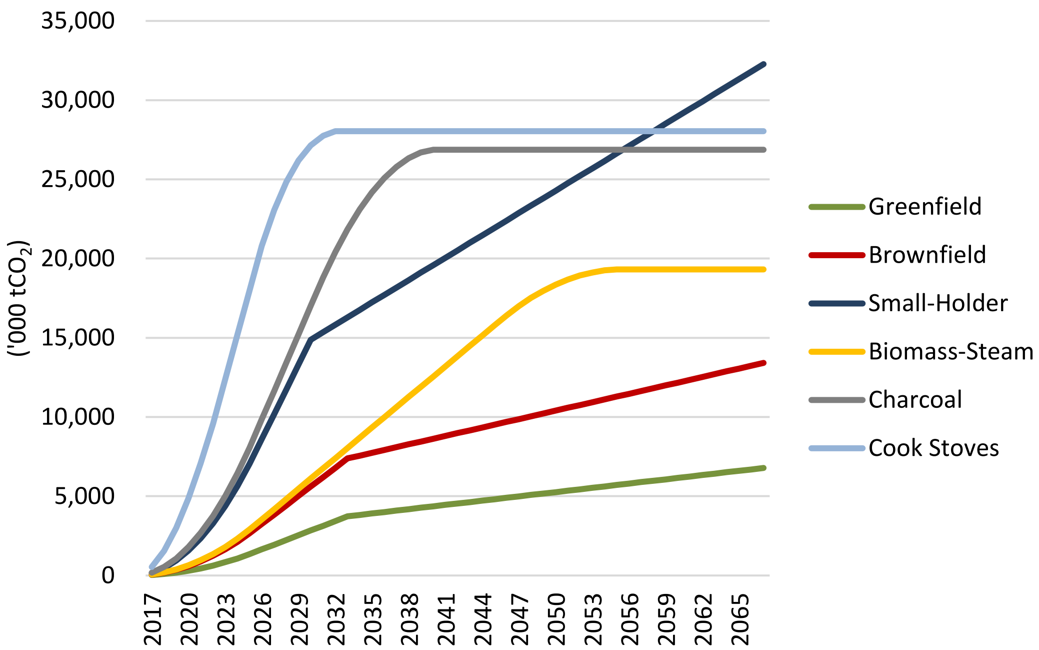
Figure 4.2 Annual Carbon Impact for US$ 100 million Invested in Different Projects



Source: CAP Calculations

[9] ibid

Figure 4.3 Cumulative Carbon Impact for US$ 100 million Invested in Different Projects



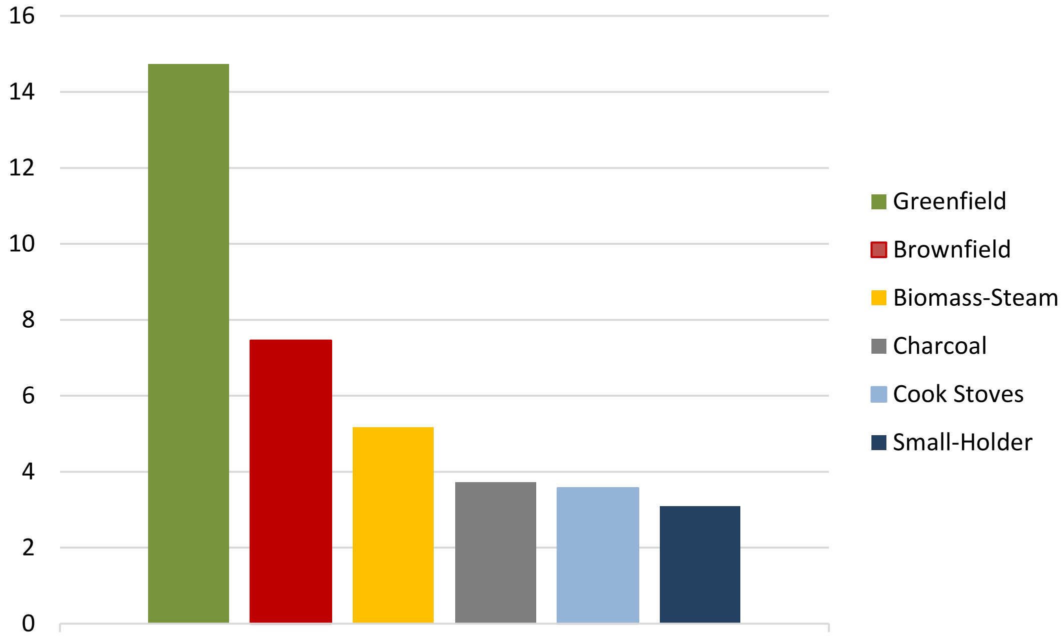
Source: CAP Calculations

The carbon impact for biomass steam projects is high because the cost of establishing a biomass boiler is relatively low, the useful life of the boiler is long, and the biomass replaces CO_2-emitting fossil fuels such as HFO.

Note that while plantations continue to yield carbon benefits after they have reached maturity due to the carbon stored in harvested wood products, the carbon benefits from investments in retorts for charcoal, efficient cooking stoves and boilers for steam production end when the equipment is obsolete. On the other hand, one associated carbon benefit of sustainable charcoal manufacturing is that it will contribute to reducing deforestation and degradation in SSA, which in turn will have both carbon and other environmental benefits. Note also that efficient cook stoves have large and long lasting health benefits beyond the carbon impact which is limited to the usable life of the stove.

The graph below summarizes the cost of achieving one ton CO_2 impact for each of the six different investment approaches. Specifically, we have divided the $100 million investment by the total cumulative carbon impact for each of the interventions to calculate the cost per 1.0 tCO_2 impact.

Figure 4.4 US$ investment per ton CO2 Impact over 50 years



Source: CAP Calculations

In conclusion, the carbon benefits of smallholder plantation development, efficient cooking stoves and sustainable charcoal manufacturing are exceptionally high, all sequestering or offsetting CO_2 emissions at a cost of less than \$4/tCO_2. It is important to keep in mind that this covers 100% of the investments for each of these three categories of interventions.

The carbon impacts for biomass steam and brownfield plantation investments are also high. We estimate the investment cost for each ton CO_2 impact to be \$5-7. Considering that both biomass steam and brownfield plantations also yield attractive commercial returns, the high carbon impact can be considered a positive environmental externality or a “bonus”.

The carbon impact from greenfield plantations is also high, but the historically high costs of greenfield plantation development in Africa makes it a less effective investment approach from a climate perspective than the five other investment alternatives in our analysis, with a cost per ton of \$15.

The table below summarizes each of the six investment alternatives in term of their carbon impacts as well as the authors’ broad assessment of their respective commercial attractiveness.

Table 4.5 Summary of Carbon Impact and Commercial Attractiveness

Category Investment/ Intervention	Level of Commercial Attractiveness	Estimated Carbon Impact (over 50 years)	Other Impacts
Efficient Cook Stoves	**Low** (Mostly Grant-based)	**Exceptionally High** (~\$4 per tCO_2 impact)	Exceptionally High Health impact
Sustainable Charcoal	**Medium** (Selectively viable commercial applications)	**Exceptionally High** (~\$4 per tCO_2 impact)	Additional High Health and Environmental impacts
Biomass Steam	**High** (Attractive commercial returns)	**Very High** (~\$5 per tCO_2 impact)	Other Impacts, incl. jobs, taxes, and energy security
Smallholder Plantation	**Low,** but can be combined w/ commercial forestry activities	**Exceptionally High** (~\$3 per tCO_2 impact)	Very High other Impacts, incl. jobs/ income distribution
Brownfield Plantation	**High** (Attractive commercial returns)	**Very High** (~\$7 per tCO_2 impact)	High other Impacts, incl. jobs, taxes, and the economy
Greenfield Plantation	**Medium** (Has been challenging historically without soft money)	**High** (~\$15 per tCO_2 impact)	High other Impacts, incl. jobs, taxes, and the economy

While a more robust carbon impact assessment for the different forms of forestry interventions would need to involve a comprehensive life cycle analysis, we believe the high-level results presented here reflect a reasonable ranking and magnitude of their respective relative impact.

We caution that this analysis of the carbon impact for different investment approaches takes a high-level simplistic approach to very complex and dynamic carbon accounting. Nonetheless, we believe it is a reasonably method for comparing the carbon impact between different investments.

5. CONCLUSIONS AND RECOMMENDATIONS

The challenges facing the forestry sector in SSA are daunting, in particular relative to the resources available to tackle the issues. The current industrial roundwood demand of about 100 million m^3 per year is growing at an estimated rate of 5-7% p.a., a trend that is driven by demographics and urbanization. Already the equivalent of around 30 million m^3 per year is imported, and another 36 million m^3 is harvested from natural forests.

Since Africa's natural forests are already being exploited beyond a sustainable level, we may ask what it would take in terms of plantation development to address the growing gap between supply and demand. Assuming a constant level of imports and natural forest harvesting, the supply shortage for IRW is growing by an estimated 6 million m^3 every year. Assuming a reasonable growth rate of 18 m^3/ha/year, an additional 330,000 hectares of well-managed plantations would need to be planted each year. To replace the current imports, an additional "catch-up" area of around 1.6 million hectares would be required. Currently only around 10,000 hectares of new industrial forestry plantations are being established per year.

In addition to the political and logistical challenges of securing enough land to establish such large new plantation areas, the cost and management required are also major barriers. Based on our benchmarking data for greenfield planting, new plantation establishment costs an average of $5,700 per hectare. Establishing 330,000 new hectares per year would require about $1.9 billion in annual investment, over 30 times the amount of annual investment over the past few decades. Smallholder plantations could be established much more cheaply (at about $1,000 per hectare in our benchmarking analysis, or $430 million for 330,000 new hectares. However, as noted earlier, the quality and productivity may be less than industrial plantations, and it is not yet clear that commercial investors can earn a reasonable return investing in smallholder forestry.

Clearly, it is unrealistic to believe plantation establishment alone can solve the emerging wood supply gap in Africa. The figures above don't account for fuelwood demand, which currently consumes over 600 million m^3/year, much of it from degrading miombo woodlands. Other interventions, such as more efficient use of fuelwood (notably charcoal production and cooking technology) will need to play a role along with the used of alternative energy sources to wood.

However, new plantation development, and in particular community-based smallholder plantation establishment, can play an important role to meet some of the increased wood demand. In fact, behind all the problems facing the African forestry space and the continued low level of investor appetite, we believe a range of good opportunities is emerging for development agencies and impact investors, as well as commercial investors.

5.1 Conclusions Regarding Plantation Investment Strategies

A central objective of this analysis has been to make an assessment as to where scarce capital should be invested in the African forestry sector for maximum impact. The cost benchmarking and subsequent analysis of the impact in terms of jobs and carbon suggests a number of general conclusions that may serve as a guide for actors interested in the African plantation forestry sector.

5.1.1 Greenfield Plantations are Expensive, But Existing Projects Should Be Supported

Based on the empirical evidence gathered for this paper, our analysis suggests that the establishment of new greenfield projects is likely to be associated with prohibitively high costs from a commercial perspective, especially if the cost of capital is considered. Because of the high cost of greenfield establishment, the carbon and employment impacts of greenfield investments (per invested dollar) are also lower than one would hope for in ideal circumstances.

However, the greenfield projects that have been established by pioneering investors during the past two decades have expanded the investable universe and will be critical sources of scarce timber as Africa awakens to the enormity of its needs. Though costly, these greenfield projects have created livelihoods, seeded an industry, and introduced admirable standards of corporate behavior in the areas of health, safety, environment and community. Some are facing challenges due to implementation errors, market headwinds, and investor fatigue, but it is important for the sector and Africa that these projects not only survive, but thrive. Moreover, these hard-earned greenfield project sites can serve as “model farms” and industrial centers for the establishment of community-based smallholder programs in the areas.

We recommend that these existing greenfield projects should receive continued support from developmental financiers, perhaps with creative financing mechanisms that draw on the growing pool of multilateral climate funds. Historically, many of the existing government plantations in Africa were established with non-commercial development financing from entities such as the World Bank and CDC. Establishing new greenfield plantations in Africa to address the growing demand for wood fiber on the continent will similarly depend upon pools of capital which do not require a commercial rate of return.

5.1.2 Brownfield Plantations Can Generate Additional Supply at Lower Cost

Our cost-benchmarking exercise has shown that the rehabilitation of existing (“brownfield”) plantations offer the most cost-effective strategy for commercial investors to establish large-scale plantation forestry projects in Africa. Moreover, brownfield investments on average yield a significantly higher overall impact in terms of jobs and carbon sequestration.

There is value to be extracted from the continent's existing plantation assets, which are producing far below their biological potential, and well below the market's rapidly growing demand for timber. Yet opportunities for private investors to access transactions in the sector are limited: many of the continent's large-scale plantations are in state hands, vast tracts of them unplanted, over-harvested, or managed inefficiently.

In Malawi, for example, 53 000 hectares on the Viphya Plateau that used to be planted to timber plantations currently lie barren of trees. These areas were over-harvested under a concession system that failed to deliver revenues to the state, or to halt deforestation. Zambia's state owned plantations are routinely over-harvested as the country's rapidly-falling supply of timber attests. Poor silviculture has left a stock of trees that can never be sold in value markets because the quality is too low. In private hands, these plantations could be producing multiples of what they are supplying currently, supporting formal, tax-paying downstream manufacturing enterprises, and creating employment for thousands.

Developmental institutions should encourage forest sector reform in Africa, including helping governments to undertake well-structured privatization processes that encourage responsible investors to acquire and manage these forest assets. This includes post-investment monitoring and performance assessments of operations, including environmental and social practices. Recent efforts by IFC to encourage the Governments in Ethiopia and Zambia to restructure their parastatal forestry assets in some form of a PPP are examples.

5.1.3 Smallholders Can Play a Central Role in Increasing Wood Supply

It has become increasingly difficult, if not impossible, to find large, contiguous areas of uninhabited land for timber plantation development in SSA. Investing in forest plantation development through small-scale tree growers is still in its nascent stage, but the scope of areas and livelihoods that could be positively impacted by such smallholder developments is enormous, particularly if such developments are operated in close coordination with high-quality downstream industrial partners.

Our analysis found that smallholder plantations can be established at a relatively low cost per hectare, while also creating positive impacts in terms of both income generation and climate change mitigation. Another positive developmental parameter—which is outside the scope of this paper—is that smallholder plantations involve broad distribution of economic benefits to lower-income families. By extension, smallholder developments also largely avoid the politics around "land grabbing" which have created challenges for a number of greenfield plantation projects in Africa in recent years.

We believe the time is ripe for a rapid growth in the establishment of smallholder plantations in SSA. Land (though it may have other uses) and labor are available, so it is ultimately a question of education, organization, training, and support. The growing fuel-wood crisis will encourage communities to establish plantations to cover basic needs, while also having the opportunity to generate extra income from the higher value products of their plantations.

There are many examples around the world of successful establishment of extensive farm forestry and out grower programs. One common success factor for these programs has been access by the smallholders to dependable markets for their wood. This is now starting to happen in Africa, which is why the potential for a dramatic scaling up of smallholder plantation development is now becoming realistic.

A key challenge of the smallholder plantation approach is that without close coordination with, and support from a strong technical advisory function or downstream industrial player, smallholder plantations will likely produce low value harvests and higher value products will continue to be imported. In spite of the early success of programs such as Komaza in Kenya, Uganda's Sawlog Production Grant Scheme (SPGS), or the Finnish funded Private Forestry Programme in Tanzania, in expanding the areas planted by smallholders, it remains to be seen whether these smallholders will be successful in securing attractive markets for their products.

During the last decade or so, there has been a development within the small-scale forestry movement towards establishment of tree/timber growers' associations (TGAs). TGAs are mutual interest groups that aim to support individual tree growers by assisting them to overcome both technical and financial barriers. TGAs provide a potential entry point for an investor or donor for channeling funds for plantation establishment or technical assistance. There are currently active TGAs at least in Tanzania and Uganda, both of which have originated from development cooperation projects in their respective countries. Viable TGAs may provide an effective model for both financiers and markets to engage with smallholders. Development of these pioneering organizations should be prioritized if smallholder tree growing is to be implemented in large-scale.

With regard to market challenges for smallholders, outgrower programs sponsored by some of the larger industrial companies have the potential to play a positive role. The outgrowers benefit from the overhead and technical support offered by the companies, as well as a ready future market for their products. The companies benefit by having a larger supply of wood to process in their industrial facilities, spreading overhead costs. A number of East Africa's larger forestry companies, including Green Resources, New Forest Company, and Kilombero Valley Teak Company, have established outgrower programs, leading to positive developmental impacts. Investors in current brownfield and future greenfield plantation projects could consider establishing smaller nuclei of industrial forestry around which out-grower programs could be established for small farmers from neighboring communities. Developmental institutions and multilateral donors should consider offering financing and technical assistance resources to further catalyze high quality outgrower programs in partnership with industrial players.

5.1.4 Investments in Downstream Processing Will Create Value and Catalyze Planting

As evidenced by the rapidly growing import of basic building materials, there is an emerging opportunity to establish local manufacturing of basic building materials. The combination of a stagnant supply and rapidly growing demand for wood products (for energy and solid wood) are driving prices up for most wood products. Suppliers of solid wood products such as panels, poles, plywood, joinery, and biomass energy will be well positioned to recognize growth and profitability as these trends continue.

These local manufacturers and supplier play an important role in the forestry value chain by supply markets to growers of timber, particularly those with smaller holdings who cannot justify their own investments in manufacturing. In a number of East African countries, the manufacturing sector is poorly developed and informal, leading to concerns that plantation owners will not be able to recognize the fair value for their forestry investments. Commercial investors should be encouraged to invest in the forest industry as the plantation resource matures.

5.2 Key Roles for Different Actors: Working Toward Common Objectives

To accelerate developments and maximize impact of the scarce capital and resources available, it is important to take a holistic approach to public policy, developmental interventions, climate change mitigation motivated financing, and commercial investments. Each group of actors starts from its own set of objectives and constraints. However, by recognizing their key contributions to the broader landscape of African forestry and coordinating their interventions where appropriate, the impact for each individual actor has the potential to be significantly higher than when acting in isolation.

A positive vision for the African forestry space could involve the following players working together:

- *Commercial investors* managing industrial clusters, modest sized plantations with state-of-the-art nurseries, best silvicultural practices, and downstream industrial developments that create local markets for both their own plantations, and for extensive out-grower programs. The importance of investment in manufacturing and downstream activities should not be underestimated. It is a prerequisite for successful investments in plantations, and a lack of downstream options is often a contributing factor to the high commercial failure rates of greenfield plantations.

- *Local communities* participating in smallholder plantation programs, supplying wood to the industrial facilities, including sustainable and efficient charcoal manufacturing. Community-based smallholder plantation development is already taking hold in many countries in East Africa and we believe this trend will accelerate, particularly if the farmers have access to attractive downstream markets for their wood.

- *Carbon financing programs* providing high impact incentives to smallholders enabling them to massively scale up community-based plantation development across SSA, as well as funding to encourage sustainable charcoal manufacturing and the distribution of efficient stoves (both very high carbon impact interventions). As illustrated in the paper, the carbon impact of a number of different intervention in the African forestry sector can be very high, with investments of less than $4 per tCO_2 impact.

- *Developmental Institutions* should encourage the public sector in Africa to establish PPPs for better management of forest resources while separately providing the private sector with capital to establish downstream operations.

6. APPENDIX A: THREE PLANTATION INVESTMENT STRATEGIES

6.1 Strategy 1: Develop New Greenfield Plantations

a) How are financial returns generated?

The greenfield timber investor establishes a plantation where there previously was none, recognizing that the enormity of Africa's fiber shortage will inevitably create opportunities for fiber owner in the future. Under this strategy, a significant degree of patience is required as capital is put to work for long periods of time before any gains from the investment can be realized. Greenfield investors in Africa believe that the value of their investment can only grow with time as the timber supply gap widens, African consumer incomes grow, and African cities only get larger and more fiber-hungry.

Generally, these greenfield investors also settle on an industrial plan at the time of plantation establishment, whether targeting long-rotation species such as teak (for export, or for domestic furniture markets) and pine (for construction lumber and furniture), or shorter-rotation trees such as eucalyptus (for biomass in the most extreme cases, electricity poles in intermediate cases, or tropical hardwood substitution in the longest-rotation cases). In many cases, the greenfield plantation owners choose to forward integrate into manufacturing when there is sufficient fiber to sustain an industrial facility and thereby capture as much of the value as possible from the trees. As noted previously in this paper, inefficient logistics and downstream processing in Africa lead to a significant degree of value-destruction and diminished ability for manufacturers to pay for trees. Integrated greenfield plantation and industry allows the investor group to plan well in advance for an optimum value-creation strategy, subject though it may be to prevailing market forces at the time of maturity.

b) What are the risks?

While greenfield establishment offers many advantages, it is also fraught with risks. Firstly, the introduction of industrial plantation forestry requires the occupation of large tracts of land, and it is rare to find such large parcels of land that are not already in some use. Local communities are often informally using this land – sanctioned or not by the government, tribe, or private owner – and may resent the subsequent restriction of their use of land by the new plantation owner. There may be boundary disputes or disputes over resources on the land (e.g., water sources), and conflicts with small-scale agriculture or other alternative land uses. Local communities that are not sensitized to plantation forestry in their area are likely to have less fire danger awareness and less preparation to avoid inadvertent fires or fight them. In the most rancorous cases, arson fires may be started whose implications are not well-understood. In other words, establishing a social license to operate is one of the greenfield investor's biggest challenges. At the same time, in Africa, it is often difficult to realize the full value of one's efforts in government advocacy, community consultation, and legal permit processes required to operate a land-rich business, as land is usually a non-transferrable asset.

In addition to the risks surrounding the customary land rights in Africa, often involving competing uses of land, greenfield establishment also carries implementation risks around the growth of the trees themselves. By definition, forestry in those areas is an unproven enterprise and for a long time, uncertainty remains around optimal matching of sites and soils with species, area or site-specific silviculture, susceptibility to local pests or diseases, and the existence of a reliable supply chain (of plant material, equipment, qualified labor, etc.) Thus, unexpected delays, unforeseen costs, and cost overruns are frequent in such projects.

Finally, there can be a risk to a greenfield plantation's FSC certification if establishing the plantation involves any clearing of an existing natural forest, even if that plantation increases the stock of trees in the area.

c) What are the limitations of this strategy?

The main limitation of the greenfield strategy is that there are few areas in Africa – especially those linked to markets by sufficiently-good logistics systems – in which to find large enough tracts of land to plant where community or forest conversion risks are manageable. It is also costly and time-consuming to navigate successfully the various levels of consensus required to install a greenfield land project in Africa – from central government approvals, local government permits, consent from customary authorities, and community buy-in.

d) Timeline for impact.

Of the three strategies examined, greenfield planting requires the longest time before its impact – financial, operational, or developmental – can be realized. It can take several years to obtain the necessary approvals for a project, while operations scale up at the rate that the biological growth of the trees requires.

It is important to recognize that the application of a commercial cost of capital for African greenfield projects with long implementation periods (e.g., long rotation species such as pine and teak) makes it difficult to find viable projects.

Greenfield Case Study 1: global-woods AG, Uganda

Formed in 1998, global-woods AG is a German forestry company that began operating in Uganda in 2002. The company has a license to plant trees on over 12,000 hectares that constitute the Kikonda Forest Reserve in the West of the country. The reserve, gazetted for forestry in the 1960s, is legally owned by the Government of Uganda and administered by the National Forestry Authority.

Of 12,000 hectares managed by global-woods, about 8,000 hectares are plantable, and almost all have been planted, chiefly under pine. The growing conditions on the reserve have been described as “excellent” due to the rainfall, temperatures and soils, and the expected MAIs for pine as high as 25m^3/hectare/year and for eucalyptus up to 40m^3/hectare/year.

Initially, the pace of planting was slow, with just about 250 hectares planted in the project’s first three years, but in 2005, a new manager was hired to accelerate the pace of planting to just about 300 hectares per year. With high rates of biological growth, new plantings were compromised by the weeds that grew alongside. Since the arrival in 2012 of a new estate manager working alongside the general manager, the quality of silviculture and plantation management has improved noticeably. In addition, greater focus was placed on training the company’s contractors, and skilled local middle-management was hired and trained. The improvements made in weed control particularly have led to excellent early growth, uniformity, and survival of both pine and eucalyptus stands. The frequency of weeding and repeated application of herbicides has consequently resulted in significantly higher establishment costs compared to similar plantations in Southern Africa, but is essential in such a biologically productive environment.

Almost four-fifths of the households living around Kikonda Forest Reserve live on less than $1 a day, and their major sources of income are from crops (30%) and livestock (25%). Other sources of income include charcoal burning, business, wages and dealing in timber (Heifer International, 2010). For the past twenty years, some members of the surrounding communities have depended on the forest as a source of their livelihood, but their subsistence activities have also led to its degradation. A range of production constraints – land shortage, soil infertility, poor land management, inadequate agricultural services and inputs, drought and water scarcity – has forced community members to use the land more intensively than is optimal for the natural forest, but they have limited survival options.

Global-woods expends a great deal of effort in managing community challenges, and the company's stakeholder relations manager is a member of the senior management team. GW has also benefited from significant grant support from DANIDA for community development projects, which have included construction of a health clinic and school, environmental education initiatives, work with cattle keepers on improved farming techniques, and more. The company plans to keep investing resources to sustain these community programs and to maintain goodwill from the local populace.

global-woods' initial business plan was to earn income from the global carbon markets. As this market has not developed as anticipated, the timber from its eventual harvests will have to find traditional timber market applications. As with the Ugandan tree farmers who have established plantations under the country's Sawlog Production Grant Scheme (SPGS), the challenge for global-woods will be to find markets when the wave of timber anticipated to hit the market (1 million m3 by 2020 and 1.6 million m3 by 2040) comes on stream. We highlight the SPGS as a case study in our community-based plantations section.

Greenfield Case Study 2: Rift Valley Forestry – Niassa, Mozambique

Niassa province in northwestern Mozambique is the poorest, most remote region in one of the poorest countries in the world. In the early 2000s, the Mozambican government was made aware of the area's biogeoclimatic suitability for forestry development and assessed that the timing of forest industry development would fit well with the planned longer-term development of rail and road infrastructure.

In 2004 Rift Valley Corporation responded to a Request for Proposals put out by the Mozambican government to develop a greenfield forestry business in the Niassa region and formed Florestas de Niassa ("FdN"). FdN was granted a large concession area east of Lichinga, the provincial capital. After forming a small core team comprised of Mozambicans and other African expatriates, FdN planted its first trees in 2007. After a considerable learning curve involving improvements to site-species matching, site preparation techniques and training up a labor force previous unaccustomed to formal employment, FdN reached a peak planting year in 2014 with 2,650 hectares of new plantations, employing over 1,000 people.

The total planted area is 7,400ha as of 2016, with an eventual objective of having at least 30,000ha producing a variety of forest products including sawlogs, transmission poles, and biomass for energy. These products will be sold regionally, but dramatic recent improvements in the railway to Nacala will allow for exports to Asia. As is the case with FdN's sister company, Border Timbers in Zimbabwe, the company will be fully integrated, with downstream manufacturing established near the plantations.

FdN has an effective Community and Social Responsibility Program, and follows international best forestry practices. One strategy that has worked particularly well has been to engage communities and community leadership as forestry contractors (Small Business Enterprises, or SBEs). This model provides a feeling of ownership in the forestry development process and promotes local entrepreneurism. Some of FdN's best plantations have been planted and are managed by community contractors. Uncontrolled deforestation due to slash and burn agriculture and charcoal production is rampant in the region and already posing a major threat to the viability of the neighboring Niassa Reserve, a wildlife protection area that is one of the largest protected areas in the world. Rift Valley Corporation has been the driving force behind the LAGRI Integrated Land Use Plan which proposes to develop a multiple land use framework on over one million hectares as a buffer zone for Niassa Reserve. Within the area will be zones identified for natural forestry management, pure conservation, conservation agriculture and plantation forestry. Effective implementation will increase agricultural yields per hectare, protect high value habitat and generally reduce the destructive footprint on the landscape by creating sustainable SBEs. This plan has considerable support from both the provincial and central governments, but will need international finance support to realize the landscape level vision.

6.2 Strategy 2: Rehabilitate plantations (brownfield plantation development)

a) How are financial returns generated?

The value-creation strategy of the brownfield investor focuses on making improvements to existing operations and expanding the productivity of the asset base. In plantation forestry, brownfield investors are able to monetize the timber standing on the plantation at the time of acquisition and contribute the proceeds to re-establishment of the plantation under an improved management plan. By replanting with better genetics, practicing disciplined silviculture, and targeting value markets, brownfield investors aim to reap the returns on their investment by improving the productivity and profitability of the plantation asset.

Because the fiber asset is usually part of an established value chain, it is not always necessary to install manufacturing capacity where it did not previously exist. As noted previously in the discussion of greenfield ventures, it may pay the brownfield investor to invest in manufacturing if the current markets are erratic, inefficient, or under-developed. As the biological potential of the land is usually well-understood, manufacturing can be planned well in advance and the plantation established to support the manufacturing plan.

b) What are the risks?

Absent catastrophic fire risk, one of the risks of brownfield investment is overpayment for the asset, or put differently, the inability to implement anticipated productivity or profitability gains to a sufficient degree that one recoups one's investment in the rehabilitation process. This is true both for an investor who pays too high an acquisition price, and for the one whose costs of re-establishment are not rewarded by the market.

Implementation risks are not absent from brownfield investments, particularly where the strategy involves conversion of the plantation to a different tree species or growing regime, but a greater ability in general than in greenfield projects to stage implementation allows for better management of such risks.

While community risks may exist, they are often lower in the case of brownfield investments than greenfield as neighboring communities are accustomed to industrial forestry in the area, systems of consultation and communication are in place, and likely a significant part of the local economy is supported by the forestry enterprise. It is true that in some brownfield cases, encroachment can occur if the asset has been idle, or poorly-managed for a time, but in general, it is accepted that the forestry enterprise is a legitimate entity in the region.

c) What are the limitations of this strategy?

The obvious limitation of this strategy is that there is a limited universe of opportunities to choose from, as it is confined to areas where there were plantations in the past. Typically, these plantations are located in the best growing areas of a country (rainfall and soils) which sometimes may not be near key urban markets. However, since there have been plantations present in the area, there are often established infrastructure, industrial capacity, knowhow and downstream market developments.

d) Timeline for impact

While the impact of creating a greenfield enterprise where none used to be may be obvious, the impact of rehabilitating a plantation or improving its productivity is usually more difficult to observe and measure. Often the impact of brownfield investment is seen in preserving what already exists, and if possible, expanding it. In other words, in some cases, the impact may be immediate, and in others, may take as long as a greenfield project, depending on the state of the plantation at the time of investment. However, since the productivity of the existing plantation stock in SSA is low, the impact of investments to improve the management and productivity can be both higher and accrue more quickly than for greenfield. A key component of the impact for investments brownfield plantations also relates to how the plantation can be better adapted to dynamic changes in the market. This could involve changing or adjusting the silviculture regime to produce different log grades to meet new demand and/or investing in new or better manufacturing processes to adapt to changes in demand.

Brownfield Case Study 1: Peak Timbers, Swaziland

Peak Timbers is a 20,000 hectare plantation company in Northern Swaziland that was acquired by GEF's Africa Sustainable Forestry Fund in May, 2012. The plantation had originally been planted to pine, and then established as a eucalyptus pulp estate to feed paper giant Mondi's paper mills in South Africa.

At the time of ASFF's acquisition, the plantation was still suffering the after-effects of a catastrophic fire that had burned almost 16,000 hectares of commercial area. Not only did a large part of the plantation remain burnt, but the area that was classified as "green" had been established under sub-optimal practices with coppice material pre-dating the 2007 fire, leaving those areas at least a decade behind in genetic improvements that had since occurred. High biological growth rates on the estate meant that the burnt areas had morphed into almost-impenetrable "jungles" often on steep slopes. Not only did were these areas an ever-present source of fire danger, but steep slopes and "widow-maker" branches on rotting trees made them a peril for harvesting crews.

ASFF's turnaround strategy was to get the plantation "green and growing" again, re-establishing it with the highest quality genetic material, employing leading experts of soils and site-species matching, and employing the most disciplined techniques of silviculture to preserve value in the trees that were growing – both in the ground and newly-established. The plantation's previous owners had not had the financial means to make these investments, and so ASFF's task was both to "catch-up" on the neglected areas that could be salvaged, and to implement a high-quality growing regime for the new stock of trees.

Over one-third of the plantation area had been slated for low-value pulp when ASFF took over, with densely stocked stands of unpruned trees. ASFF has been converting the plantation to produce value product, such as transmission poles and clear sawlogs, applying a silviculture plan that allows for some flexibility in target products.

Brownfield Case Study 2: Longmore Plantation, South Africa

The Longmore plantation provides an example of how brownfield investors can apply incremental, integrated value creation strategies to raise the productivity and profitability of an underperforming forestry asset.

Located in the Tsitsikamma area in South Africa's Eastern Cape province, the Longmore plantation is part of the Cape Pine group of plantations (now owned by the MTO Group) and consists of almost 11 000 hectares of commercial area planted to pine. Established in the 1920s as a job-creation scheme by the South African government, the plantation is characterized by shallow soils, marginal rainfall, high mortality rates, and low growth rates. Furthermore, its steep, rocky slopes make harvesting relatively expensive.

Despite these attributes of Longmore of slow growth and high mortality, the commercial strategy for the plantation followed that of its "sister" plantations in Cape Pine's Tsitsikamma unit, even though the other plantations had far better growth sites and climatic conditions. As a result, *Pinus radiata* and some *Pinus pinaster* was planted at Longmore and grown for large sawlogs and for poles. Demand in the company's sawmills and the local market was for large-dimension sawlogs, which took thirty years to grow on the plantation, while poles grew over as much as 25 years.

In 2005, a fire ravaged the plantation, burning about 90% of the commercial area. A salvage operation began, and a Hew Saw was temporarily installed to cut the fire-damaged logs.

In 2010, GEF's ASFF fund became the majority shareholder of Cape Pine, and together with the company's management began to devise a value-creation plan for Longmore and other Cape Pine assets. Utilizing information from a site-species matching study, they found that Longmore's growing sites were better suited for short-rotation crops, and that *Pinus elliottii* showed lower mortality rates than *radiata*. *Elliottii* was also found to be more fire-resistant.

The Hew Saw at the Longmore Sawmill could process only a limited diameter range, and the growing regime that targeted a harvesting age rather than a required diameter impeded the forestry recovery (in effect the utilizable MAI of the trees). ASFF and MTO management persuaded the plantation´s foresters that growing trees to a target diameter-breast-height (DBH), rather than to a certain age, could greatly increase forest recovery.

MTO commissioned a study on silviculture strategies for timber quality, which informed the new planting regime towards a high initial stocking, while changes to silviculture regimes designed for short-rotation crops reduced the need to thin. This, as well as a reduction in the number of required prunings from three to one, created large cost savings. With a growing strategy better optimized to its circumstances, Longmore was able to adopt a more suitable industrial strategy as well. Rather than being shut down after the burned logs were liquidated, in 2012 the Longmore sawmill was made permanent and upgraded. Today, 95% of Longmore´s area targets a small sawlog regime compared with 4% at the time of ASFF´s takeover. Moreover, whereas almost 60% of the plantation´s area was previously for large sawlogs, the current figure is less than 5%.

A significant part of the value creation at Longmore has been the utilization of biomass, which had lost its market after a local pellet plant targeting the European energy market failed with the cessation of subsidies for biomass energy on that continent. Rather than a waste product (and a cost), this biomass is now earning value for the Longmore business unit as it is burnt in a boiler to sell steam-as-a-service to a neighboring dairy.

6.3 Strategy 3: Support smallholders

a) How are financial returns generated?

The authors believe the support and promotion of smallholder plantation development represents a cost-effective approach to address the growing wood demand in SSA while also yielding high developmental and climate change mitigation impacts. However, it is important to note that most interventions to support smallholders in SSA have so far been grant-based and that there is not yet a proven approach for commercial investors to target smallholders.

Supporting small-scale tree growers as an investment requires more of a hands-on approach than only injecting capital into a company. A common type of small-scale support system begins from supporting tree growers with high quality inputs and technical assistance to enable high quality final products.

The modalities of small-scale tree grower support are many and the financial returns are generated through decreased costs of raw material and/or through more secure source of raw material for a nearby manufacturing facility. In some cases, insufficient areas of land for industrial scale plantation forestry mean that supporting small-scale farmers is the only option to increase log intake into a sawmill or other manufacturing facility. Currently existing contracts for small-scale support have included clauses for first rights of refusal and/or shares of company ownership of standing trees. In addition, a well-functioning out-grower support system that benefits both the company and the local small-scale farmers may well act as good publicity within the communities and validate the company's social license to operate.

Investing into small-scale forestry without an existing manufacturing facility nearby does not necessarily create such direct returns. This option is viable for development finance institutions that have additional motives to that of investing for financial return. For example, Komaza (see Text box) has created a model for supporting private small-scale forestry for various DFIs and other philanthropists. The Komaza model aims to create vibrant industrial activities around the developed plantations thus improving local livelihoods.

b) What are the risks?

The key risk of supporting small-scale tree growers is breach of contract. While the company invests time and money to the growing stock, the tree grower might harvest trees prematurely and/or decide to side-sell the harvest and thereby avoid any debt payable to the party that assisted with improving the plantation output. This risk may be mitigated by proper capacity building on financial returns of plantation forestry if proper rotation periods are applied. In addition, the relationships between the company and the tree growers need to be good and be based on trust.

Another risk to consider is the quality of trees. Managing a small-scale support system in which the tree growers work on their own plantations might cause problems with the expected quality of the plantations. In particular, management practices that are not commonly done by farm foresters may be difficult to incentivize. These include, for example, weeding of young plantations and pruning. This risk may be mitigated by well-planned and staged disbursement of support to tree growers during the first years of plantation establishment, not only during the first year. Quality of small-grower plantations in SSA can vary considerably. In some cases, tree growers maintain their plantations exceptionally well and quality is close to industrial plantation quality. In some cases, however, the quality can remain low. In order to mitigate the risk of low quality, the investor needs to understand the motivations of the tree grower. The mindset of the farmer might be very different to that of the investor. Returns for the farmer's investment actualizing after 15 to 20 years are often too far for him/her to consider them as reliable. Therefore, the tree grower might make decisions to maximize his/her welfare within a shorter time perspective resulting in poor returns for the investor.

Although there are efficient ways of mitigating fire in large industrial tree plantations, organizing tree plantations through small-scale support helps to further decrease the risk. Distributing productive forest assets into smaller units helps in diversifying the risk, and on the other hand an existing and properly working small-scale support system may improve the company's image within the community preventing possible sabotage.

c) What are the limitations of this strategy?

There are only a few geographies with reasonable nuclei of small growers where manufacturing can be installed in the short to medium term. For more patient capital, the potential to establish such small-grower programs is far, far greater, in terms of area, than establishing industrial scale plantations. Management of such a system in large scale, however, demands for an efficient management system that includes close monitoring of the plantations.

d) Timeline for impact.

The impact of an investment in small-scale tree growers comes in various forms. First off, investing in poor communities through small-scale support systems potentially improves livelihoods of local farmers and small-scale tree growers already within a few years if support for establishing tree plantations (payments for labor) provides additional income compared to the situation before the investment. Secondly, the support is in most cases a viable investment with actual returns on investment. The returns will actualize after the rotation of the woodlots i.e. the first final harvests will be realized after roughly 15 to 20 years from original investment. Returns for the investment of small-scale plantation forestry vary considerably based on local conditions, species and management of the plantation. IRR on investment for example, for a small-scale tree grower in the Southern Highlands of Tanzania can reach upwards of 15%. These best cases assume industrial yields with small-scale costs

Smallholder Case Study 1: Ugandan Sawlog Production Grant Scheme (SPGS)

The Ugandan Sawlog Production Grant Scheme (SPGS) is often regarded as a successful example of a forestry incentive scheme. The European Union and the government of Norway supported the establishment of the SPGS in 2004. During its first phase (2004-2009), the SPGS supported the establishment of 10,000 hectares of tree plantations. The area was planted by 106 tree growers and 43% of the total area planted was in plantations with areas of 200-500 hectares.

The SPGS supported private-sector individuals, associations, and companies that planted a minimum of 25 hectares. The grant was fixed at approximately USD 350/hectare - 50% of the cost of establishing the plantation. The payment was made in three tranches spread across two years after certain criteria were met. No upfront payments were accepted: farmers had to invest in plantations themselves and only upon successful fulfilment of the criteria did they receive the grant.

The second phase of the SPGS, which ran from 2009 to 2013, continued supporting tree planting in Uganda. Another 30,000 hectares were planted through the grant scheme and some 30,000 additional hectares were planted independently outside of the scheme. The third phase to the SPGS is currently under preparation.

While the Ugandan SPGS is a grant program and not an “investment strategy” we think it is an important case illustrating that a grant based incentive program can be a viable approach to establish Smallholder plantations. Viewed in the context of impact (notably job creation, distribution of economic benefits and carbon sequestration) relative to the USD 350/hectare, we believe the Ugandan grant scheme performed quite well.

Smallholder Case Study 2: Tanzanian Tree Growers' Associations Scale Up Wood Production from Smallholders

Small and medium scale tree farmers have become a significant group of plantation owners in Tanzania. Based on the recent surveys already half of Tanzanian forest plantations are private family-owned assets. It is anticipated that their share of timber plantations in the country will continue growing. The main challenge for the private tree growers is integration with industrial supply chains. So far, the most efficient ways have been private tree grower's associations and forest companies' outgrower schemes.

The first Tree Growers' Associations (TGAs) were established in Tanzania only a decade ago by private forest owners and since then they have grown in number. Working as an association, the farmers can improve quality and increase the volume of timber production as well as improve access to timber markets. TGAs can have major bargaining power with other market participants. The benefits of TGAs are seen, for example, in more efficient delivery of technical advice and in economies of scale in plantation management. Currently, there are some 100 active TGAs in Tanzania's tree growing hotspot, the Southern Highlands. In 2016, the Tanzanian TGAs formed an umbrella organisation to represent the TGAs in national level decision making. The TGA registered some 12,500 hectares of TGA members' plantations in April 2017. The registration process is ongoing.

TGA development in Tanzania has faced some serious challenges during its early years of development, which has been driven by donor funding, e.g. from the Government of Finland, which has assisted the TGAs with technical assistance and material support. The challenges have mainly been a result of miscommunications between the development agents and the smallholders. For example, smallholders have often failed to grasp the rationale for TGA development, while TGAs have in practice simply functioned as vehicles for receiving donor support from development bodies, and not as viable organisations providing valuable services to their members. The benefits of TGAs will eventually be realized once the smallholders have timber for sale and can commence joint marketing and sales. Due to larger available volumes, this will likely attract buyers from value-added processing, resulting in higher stumpage prices than before. Eventual streams of income to TGAs will also increase their capacity to provide more meaningful services to their members. Currently, most TGAs are still very young organisations and organisational development will still take some time.

While still young and developing, TGAs provide an excellent opportunity for investors and industrial operators. Smallholders organised into TGAs – especially the more advanced TGAs – can collaborate with industrial operators and provide additional raw material sources, decreasing the dependence on large industrial plantations to feed sawmills and other industrial operations. Efficient and professionally-managed TGAs can provide good quality roundwood with lower transaction costs than purchasing directly from smallholders. Integrating well-functioning TGAs into plantation investment strategies in Tanzania, and similar associations in other countries, may enable investors to access more good quality raw material while also having a positive impact on local livelihoods.

Smallholder Case Study 3: Komaza – A Social Enterprise Supporting Tree Plantation Establishment

Another example of a support mechanism for forestry is the US-based social enterprise Komaza. Established in 2008, Komaza is currently operating in the southeast coast of Kenya. Komaza's microforestry approach combines microfinance and sustainable forestry.

Komaza provides farmers with support throughout the forestry value chain. The farmer package with Komaza consists of 1) training in the best forest management practices, 2) the best possible planting inputs, including *Eucalyptus grandis x camaldulensis* seedlings, seeds for short-term crops, water-retaining polymers, and fertilizers, 3) maintenance support throughout the rotation, 4) harvest and sales support, and 5) after-harvest support, including advise on spending strategies for the new income generated from harvested trees.

Besides producing end-products such as building and fencing poles, lumber and charcoal from fast-growing tree species, Komaza aims to tackle the multiple environmental challenges in semi-arid areas caused by deforestation, such as desertification.

Komaza provides a practical and scalable model for channeling funds from various social-impact investors to tree growers and simultaneously helps to find solutions to many economic, social and environmental challenges.

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