Global Sustainable Biomass Fund

DBM 02031

Development and Monitoring of Sustainable Candlenut and Castor Biomass Supply Chains in Lombok Island, Indonesia

Public Final Report
September 2013
1. Context and reasons to start the project

Context and justification for the project

Lombok Island, Indonesia, is facing a major issue with its water and forest resources. A number of key causal factors include watershed degradation, deforestation, increasing water demand and climate change. Mount Rinjani National Park and the tropical rainforest covered foothills play an important role in Lombok’s climate and hydrological cycles; three of Lombok’s four main water catchments are connected to Rinjani. Water supply is declining and springs in the upstream areas are drying up, however, due to deforestation since the 1980’s, land conversion for agriculture and growing human settlements, and local communities are becoming more reliant on the forest for their livelihood. All these factors are encroaching on the protected native forest areas and reducing the effectiveness of the watersheds.

Since 2008, a fuel crisis has been created that has placed further pressure on natural resources and the local economy. Over the last decade, the major fuel for household cooking and for post-harvest processing of agricultural products has been kerosene. The Indonesian Government removed the kerosene subsidy for industry and household use in 2008, since then there has been an increase in fuel wood use by households and industry, including for tobacco curing (a major industry on Lombok), causing further watershed degradation both on Lombok and neighbouring islands. The leading alternative fuels promoted by government for the short and medium term, were liquid petroleum gas (LPG) for households, and coal for industry, both have potentially substantial economic and environmental issues. At the time of initiating this project, LPG was too expensive for industries and not readily available for low income households as well as at that time well publicised fears in the media regarding safety of the LPG canisters. Coal burners generate pollution, increase carbon emissions, and had the potential to enable accelerated fuelwood use.

This public-private partnership, funded by NL Agency, has been created to address the fuel crisis. The consortium, led by Fauna & Flora International (FFI), Bosch und Siemens Hausgeräte GmbH (BSH) and PT Export Leaf Indonesia (ELI). BSH is a German home appliance manufacturer that has developed a pure plant oil stove for developing countries. PT ELI is a member of the British American Tobacco (BAT) Group, responsible for tobacco growing and curing in Lombok and other areas in Indonesia. For over 40 years leading tobacco companies have been investing in farmers on Lombok, in 2011 almost 2,475 smallholder farmers were supplying PT ELI.

The consortium planned to outreach to household (in conjunction with BSH) and industrial biomass and biofuel burners (in conjunction with PT ELI) to make a long-term switch to locally-available biomass. The consortium planned to promote fuel feedstocks such as candlenut and castor bean within individual farms, community forests, and public watersheds. These products were chosen because they are relatively widely available in Lombok, can be integrated with community forestry approaches and have established market channels.
Background
The consortium builds on the solid foundations of an existing programme of work on Lombok initiated through the British American Tobacco Biodiversity Partnership (BATBP), a partnership started in 2001 between the multinational British American Tobacco (BAT) and three NGOs (Tropical Biology Association, Earthwatch Institute and FFI). The BATBP has a global focus and is part of BAT’s approach to sustainability.

In 2007, FFI (involving technical staff from their Indonesia Country Programme) was involved in piloting a Biodiversity Risk and Opportunity Assessment (BROA) tool across BAT’s Indonesia operations. This assessment tool, developed by the BATBP, is now mandatory across all of BAT’s 20 operating areas globally to assess and manage the business’s impact and dependency on biodiversity. In Lombok, two high risks were identified in need of action, one was an impact and one a dependency on biodiversity and ecosystem services (BES), though both were related: Unsustainable wood-fuel use for tobacco curing and water catchment degradation.

From 2008-2009, FFI worked with PT ELI and the local university in Lombok, Mataram University (UNRAM), to develop a method for PT ELI to monitor wood fuel used during the transition from using kerosene to coal, to monitor wood fuel use and to make recommendations for reducing unsustainable wood use for tobacco curing in Lombok. Two of the key recommendations that emerged were: 1) Alternative fuel sources which avoid the use of unsustainable woodfuel use 2) As many PT ELI farmers currently still use woodfuel, PT ELI should plant trees with the community to replace that used by their farmers. These activities should aim to restore the biodiversity and ecosystem services lost.

Concomitantly with the NL Agency consortium, since 2009, small-scale pilot activities that considered an integrated approach to watershed management also began and have grown with BATBP support.

Target group
The target groups of this project are the thousands of small-scale agricultural producers in local communities in rural areas throughout Lombok Island, the fuel supply sector, and the rural industries that depend on both for raw materials and fuel. The project targeted more than 2,500 producers and 100 rural entrepreneurs.

Location
The project has been located in Lombok Island, Indonesia. Producers from various locations on the island have taken part in the supply chains which have been established. The integrated processing for both supply chains has been constructed near Selong harbor in East Lombok.

Project partners
The project was implemented by Fauna & Flora International (FFI) (through its UK Head Quarters and Indonesia Country Programme) in consortium with, Indonesian company PT Export Leaf Indonesia (ELI), and Bosch und Siemens Hausgeräte GmbH (BSH) in Germany. The partners have been making use of subcontracted services from Singapore based biomass and biofuel company Sustainable Trade and Consulting (STC), Konsepsi and Lumbung (local NGOs active in the fields of farmer land and forest management), the Dutch Energy research Centre of the Netherlands (ECN) in collaboration with Lombok University UNRAM, and Advance Consulting BV (project administration, business planning and reporting).
2. Objectives of the project

The primary short-term goal is to promote the sustainability of certified candlenut and castor bean biomass chains. It will demonstrate ecologically sustainable and financially viable supply chains for biomass and biofuel energy production, processing and marketing at the household and rural industrial level in Lombok Island, Indonesia.

The long-term goals are to boost the local economy, alleviate poverty, and promote biodiversity and carbon conservation.
3. Activities undertaken in the project

During the project implementation period (1 May 2010 – 30 June 2013) the following project activities were planned and carried out:

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<tr>
<th>Project goal</th>
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<tr>
<td>To establish ecologically sustainable and financially viable certified supply chains for candlenut and castor biomass and biofuel energy production, processing, and marketing at the household and rural industrial level in Lombok Island, Indonesia</td>
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<tr>
<th>Activities</th>
<th>Explanation in keywords</th>
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<td><strong>1. Conceptual framework established</strong></td>
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<td>1.1 Feedstock development</td>
<td>An in-depth technical and environmental supply chain analysis, including a benchmark study on sustainability for candlenut and castor has been carried out. Site selection and selection of community producer groups has been done. Rapid livelihoods assessment (PRA/RRA) and rural industry fuel assessments were carried out to determine needs and to establish the base case. A watershed/CFM forum was established.</td>
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<td>1.2 Suppliers development</td>
<td>Different farmers groups and/or farmer cooperatives have been selected to participate in the supply chains. Standard Operating Procedures (SOPs) for suppliers were developed.</td>
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<td>1.3 Distribution development</td>
<td>Local distributors of candlenut and castor products have been identified and verified. The most cost effective means of transport for distribution were determined. SOPs for distributors were developed. ELI has identified and mobilized cooperating tobacco producers; BSH identified and mobilized cooperating households.</td>
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<td>1.4 Joint Venture / Association established</td>
<td>The consortium members have supported the organisation of producers, processors and other stakeholders in the candlenut supply chain. A business plan for the commercial exploitation of the supply chain was developed.</td>
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2. Supply chain infrastructure realised

| 2.1 | Technical design completed | An engineering design of an integrated facility for oil expelling, biomass compaction, fuel storage, and pretreatment were drawn. |
| 2.2 | Production and processing facilities established | The partners targeted the development of at least a number of 20 community nurseries involving 2,500 farmers. Apart from nurseries, a biomass compaction and oil expelling unit were constructed, including storage tanks, pre-treatment facility and a warehouse for storage and handling purposes. |
| 2.3 | Watershed (DAS) protection and community forestry (HKM) measures taken. | Field consultations with watershed conservation forum (Forum DAS) have been carried out, as well as field surveys and consultations with Konsepsi in three HKM areas in Lombok. Opportunities for including candlenut and castor into DAS and HKM schemes were identified and selective piloting of planting candlenut within DAS and HKM schemes were undertaken. |
| 2.4 | Supply contracts and off-take agreements secured | The partners have concluded three supply contracts for sustainable biomass fuels (candlenut and palm kernel shells with PT ELI in 2011 (200 tons), 2012 (2,000 tons), and 2013 (9,000 tons), one supply contract with PT. Sadhana Anfinsantara in 2011 (200 tons), and one supply contract with PT. Alliance One Indonesia (AOI) in 2013 (3,000 tons). This constitutes total contracts of 13,400 tons overall from 2011-2013. |

3. Producers and entrepreneurs trained; staff recruited

| 3.1 | Training of producers and entrepreneurs | Various farmers were trained in Best Management Practices and post harvesting techniques. Trainings have been provided via key farmers, in turned trained by the consortium and subcontractors. Various rural contracted entrepreneurs were trained in applying biomass and biofuel burner technologies for rural industries. |
| 3.2 | Recruitment of JV / Association staff | Staff for the integrated processing facility and the Association were recruited during the course of the project. |
| 3.3 | Training of JV / Association staff | All staff members received trainings in issues related to oil expelling, pressing, storage, handling, management, stock keeping. |

4. Feedstock tested and marketing strategy implemented

| 4.1 | Testing feedstock performance in household stoves | New improved stoves have been distributed to and tested at household level. However, this activity came to a premature hold as the local government decided to distribute LPG-fuelled stoves to households on Lombok for free. |
| 4.2 | Testing feedstock performance in industrial burners | Some 50 rural industries in different sectors were selected to participate in the tests; fuel performance tests have also been carried out in the lab. |
| 4.3 | Launching marketing campaign | A marketing strategy has been defined for rural industries, households and the general public. Contracts with distributors have been secured. |
### 5. Plan Vivo certification initiated; sustainability effects assessed and disseminated

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<th>Subsection</th>
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<td>5.1</td>
<td>Initiate Plan Vivo certification by developing a PIN. After doing a pre-assessment on acquiring RFA certifications, it was decided that RFA was of little added value to the local buyers market for candlenut. Hence, an alternative sustainability standard was adopted in the form of Plan Vivo. The partners have set the first step towards certification by development a Project Identification Note under the scheme.</td>
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<td>5.2</td>
<td>Assessment of the sustainability criteria. The operational supply chains are assessed against the Cramer Commission’s Testing framework for sustainable biomass. This included developing a structure for sustainability monitoring, developing a baseline survey for benchmarking purposes, local data collection and data analysis. The assessment resulted in a final report describing the environmental effects of the candlenut biomass chains.</td>
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<td>5.3</td>
<td>Dissemination of results. FFI and ELI-BAT have been attending several congresses (a.o. World Sustainable Agriculture Congress in Singapore, IUCN congress in Korea) during which the underlying project was promoted and results were shared with other participants.</td>
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## 4. Results of the project

The main results achieved are described below:

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<th>Key Result</th>
<th>Explanation</th>
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| 1 Conceptual framework established | - contractual arrangements with stakeholders established  
- rapid livelihood and rural industry fuel assessments carried out  
- benchmark study on sustainability carried out  
- watershed forum established  
Furthermore, the partners have established a legal Association representing project stakeholders, producers and processors. The associations serves as facilitator for the farmers to enter the buyers’ market with strengthened bargaining position. The Association also serves as provider of feedstock and technical service provider to local tobacco kiln industries. In addition, candlenut producers are organised in the form of a Cooperative. A financial business plan has been drawn up demonstrating the commercial outlook of the Association. |
| 2 Infrastructure for candlenut and castor bean supply chains realised; supply contracts and off-take agreements secured. | - 20 community nurseries for biomass crops established  
- integrated biomass / biofuel processing facilities constructed  
- contractual agreements for supply of feedstock made with 1,250 producers; off-take agreements finalized with potential buyers in Indonesia and abroad. Sales of biomass (candlenut and palm kernel shells) to tobacco farmers increased from about 100 tons in Year 1 of the project (2010) to over 13,000 tons in the final year (2013) |
| 3 Farmers, entrepreneurs and Association staff trained. | A number of 1,280 castor bean farmers, 1,024 candlenut farmers and 45 tobacco farmers have been involved in different training programmes. The project employed 25 staff members. Trainings were also provided to 17 members of the Association. |
| 4 Feedstock tested and marketing strategy implemented. | - feedstock tested for small industrial use with 50 rural industries  
- limited testing with improved Protos stoves with households; this testing/distribution came to a halt when the government started to fully subsidize LPG as alternative fuel  
- marketing strategy (promotion of biomass as renewable energy source, promotion of use of candlenut as feedstock for drying kilns) developed and implemented |
| 5 Plan Vivo certification process initiated and sustainability effects assessed and disseminated. | - Plan Vivo PIN developed  
- assessment against sustainable biomass policy goals carried out  
- project and assessment results disseminated to relevant public. |
Overall, the project has mostly succeeded in its short-term goal. For rural industry, it has established a commercially viable supply chains for candlenut farmers in the region. Financially, candlenut competes well with other sources of alternative fuel, selling at a price of Rp 1,300-1,500/kg which is highly competitive with coal and other fossil fuels. Although this commodity supply chain is not certified (see changes to project below), indications are that by incentivising the upkeep of existing candlenut trees as well as planting candlenut in degraded areas and preferably as part of a community agroforestry system there is confidence that the land management practices are ecologically sustainable. Regarding the castor bean, the project managed to connect farmers to a Japanese owned company on Sumbawa that buy castor-beans for further processing into bio-degradable plastics for the automobile industry in Japan. This was achieved by connecting to a Lombok based company acting as a collection entity for the Sumbawa company.

Adaptations to original project plan
During the course of the project, some changes were made to the original plan which included the following:

1) In May 2007 the Indonesia Government started it's program nationally to replace kerosene cooking fuel in the household with LPG, distributing conversion kits of stoves, pipes and LPG canisters, however, at the time the NLAgency project was being developed there was a spate of media coverage on exploding canisters which was undermining public confidence and uptake of the program. However, by 2011 the Indonesian Government quite successfully introduced their LPG cookstove program in the project location in Lombok. This entailed providing all willing families with free LPG cookstoves and an initial 3 kg-gas tank. Concurrently, the government is ensuring the availability of subsidised gas. BSH and its partners have always been clear on the fact that the Protos plant oil stove has disadvantages in comparison to gas (especially in terms of pre-heating and cleaning). In the circumstance that gas is both available and affordable, it is clear that end-users will prefer gas. The fact that gas is being subsidised and the cookstoves being given for free clearly made the further dissemination and eventual market-case for Protos highly dubious. In addition, BSH's global Protos stove programme did not achieve the results anticipated and due to 'complex technical and operational factors, coupled with the difficulties in the supply of sustainable cultivated plant oil’ BSH discontinued the production of the stove (http://www.bsh-group.com/index.php?109906). As a result, BSH completed their commitment to the testing and dissemination activity related to household stoves and stepped away from the consortium on fulfilment of their obligations in Lombok. The remaining consortium members continue to deter the use of unsustainable fuel sources, including wood, for household usage.

In addition, external and unrelated to the project, a biogas project called BIRU (Biogas Rumah) started in 2009 which is promoting household biogas from livestock in the North of Lombok is proving successful and is apparently a more appropriate sustainable fuel source for Lombok users.
2) As a result of the above development in the LPG sector, the partners decided to halt their activities related to further development of supply chains for making available bio oils for the market. Nevertheless, the project till that date managed to connect farmers to companies on Sumbawa that buy castor-beans for further processing.

3) For castor bean, there is a company in Sumbawa that is investing in a castor oil processing plant and export the oil to Japan to be used in the automobile industry. Therefore, they could afford to buy the castor bean at a much higher price than the project could. The project will use the oil for fuel, therefore the price limit of the bean is maximum Rp. 2,000/kg mean while the Japanese company bought the castor bean at Rp. 6,000/kg.

The project decided that instead of being a competitor with other players in the castor bean market, the project could collaborate with both producers and buyers, because the project still can get a potential supply of fuel from the trunk of the castor bean tree, to be used as biomass fuel. The plan for castor bean was then adapted to working together with the company to developing castor bean, with the company buying the castor bean from the farmers and the project collecting the trunk as a biomass fuel. This arrangement also gives extra income to farmers, since before they had to spend extra money to clear their land of old castor bean trunks. Now, the cost for clearing and replanting the land can be covered by selling the trunks to the project as biomass fuel.

Similarly, project partner STC decided not to pursue candlenut oil as an option for biofuel development, as the costs of shelled candlenut rose during 2011-2012 in the domestic market beyond the price level that would be commercially viable. Also, STC’s efforts to explore the international market for candlenut oil for other industries such as cosmetics, soap, and other personal care products indicated a relatively limited and narrow market. Therefore, STC decided to focus primarily on actively promoting the candlenut shells as a direct combustion fuel. This proved to be a well-justified choice, that ultimately proved highly successful in terms of creating viable demand and supply for sustainable biomass fuels for rural industries in Lombok.

4) The project initially planned to have the supply chains certified against Rainforest Alliance (RFA). During project planning, RFA was chosen primarily with the aim of accessing high-value niche markets outside Indonesia but also to help prove the sustainability of the supply chain in Lombok. However, during the project implementation the team identified that it was of more business sense to focus on the domestic market. This then removed any potential added value to the project or farmer from pursuing RFA certification. Indeed the changes to the castor bean supply chain, meant the project is only using castor bean waste (stems and leaves), and is not using the bean or involved in castor oil production directly since there is already an established supply chain for this, so there was limited option for certification. Furthermore, the candlenut supply chain is highly dispersed with some supply from Lombok, where the project sources from existing candlenut growers in community forests and from establishing new nurseries, and some bought from neighbouring islands. It is logistically difficult and costly to certify the whole candlenut chains under any certification scheme, including RFA. However, for new nurseries on Lombok, candlenut was being encouraged as part of a community agroforestry system to rehabilitated degraded watersheds. The project proposed instead to investigate the
feasibility of Plan Vivo for Lombok. This is an alternative certification system to RFA which does not certify the supply chain, but would certify community-led sustainable land management practices with an added performance-based financial reward to the community through sale of credits. If successful it would be easier for the communities to replicate themselves and at lower cost than other certification schemes. During the project period, the first step in this process would be realistic to undertake: developing a Project Identification Note (PIN).

Sustainability effects
In general, the project has been promoting sustainability of the biomass supply chain, and in particular the candlenut supply chain to various stakeholders throughout the project implementation period. These stakeholders include producers (candlenut farmers), local processing companies, buyers, financiers, NGOs and governmental authorities. STC, FFI and ELI have been promoting the use of candlenut shells amongst (cooperatives of) tobacco farmers. During the project PT ELI committed through its corporate direction to sustainable biomass which is embedding demand for sustainable biomass into business operations. In addition to the still increasing demand for candlenut biomass from PT ELI and other companies, there is also a demand from ELI for sustainable palm oil kernel shells (POKS). STC as distributing contractor for the project is able to add this biomass stream to the candlenut stream by sourcing from a RSPO certified mill in Kalimantan. This provides substantial input and stability to the biomass supply chain in Lombok. Both these commodities have proven technically suitable for curing, but must be competitively priced compared to other more unsustainable sources of biomass, be in sufficient volumes and available when needed.

FFI is participating in discussions on sustainable land, water and forestry management with relevant actors. Amongst these are local authorities, farmers and the private sector. A Lombok Watershed Forum (Forum DAS) in existence prior to the project was intended for sharing experiences, this however has been mostly inactive apart from the social forestry group where sustainability has been promoted. In relation to this project and FFI’s related activities in Watershed management a Central Lombok District Forum has been established and will further support promotion of sustainable watershed management and forest use.

In terms of the sustainability impact of the project as assessed against the Cramer Criteria, the following overall conclusions are drawn based on research compiled by ECN and UNRAM:

"For this Candlenut and Castor Bean project on Lombok, the nine Cramer principles can be positively scored. Especially the production of Candlenuts scores positively for all nine principles, although some principles are only evaluated in a qualitative way. For the environmental principles, the Castor Beans production is less positive, due to the higher use of fertiliser in this production chain."
The individual scores on each Cramer principle is summarised as follows:

**Principle 1: Positive Greenhouse Balance**
The use of candlenut shells to replace coal in the production of heat results in a substantial reduction of greenhouse gas emissions, likely exceeding 70%. With the emission reduction exceeding the strictest indicator mentioned (70%), it can be concluded that the greenhouse gas balance is strongly positive with the NTA8080 requirements.

**Principle 2: Biomass production and carbon sinks in vegetation and soil.**
Since no forests are intended to be cleared to make place for biomass production, and since formerly unused land is intended to be taken into production, the loss of carbon sinks is expected to be limited and carbon sinks are more likely to increase.

**Principle 3: The production of biomass for energy must not endanger the food supply and local biomass applications.**
The local food supply is not endangered as a result of the project; in contrast, it may actually be strengthened in the case of Candlenut.

**Principle 4: Biomass production must not affect protected or vulnerable biodiversity and will, where possible, have to strengthen biodiversity.**
Indonesia has ratified the Convention on Biodiversity in 1992, based on which it is assumed that proper regulations thus needs to be applied when allowing land use for the production of Candlenut or Castor Beans. For the production of Candlenut there is less monoculture applied as compared to other plantations. Depending on previous land use, growing of candlenut could enhance biodiversity.

**Principle 5: In the production of biomass, the soil, and soil quality must be retained or even improved.**
Indonesia joined the Stockholm convention of Persistent Organic pollutants (POPs convention) in2009. Pesticides use for Castor Beans is reported, but from the questionnaires seem limited. Most Candlenut farmers report no pesticide use. Soil quality is not seriously endangered via Candlenut and Castor Bean production. Growing candlenuts on sloped and marginal lands is done also for erosion protection and thus retaining soil.

**Principle 6: In the production and processing of biomass ground and surface water must not be depleted and the water quality must be maintained or improved.**
Candlenut does not require any irrigation. Castor Bean requires only limited use of irrigation which may have some effect on the nutrient concentrations in ground and surface water. The limited use of pesticides and artificial fertilisers for Candlenut production are likely to prevent depletion of the water quality.

**Principle 7: In the production and processing of biomass the air quality must be maintained or improved.**
No large shifts in emission and/or concentration levels due to the change in fuel are expected. The shift from diesel/kerosene to burning of the Candlenut shells/Castor oil may even result in lower emissions of sulphur (often present in oil derived products) and thus lowering the level of acidifying substances. While the products will be mainly used by the tobacco industry, installation of new
(more efficient and better controlled) ovens will have a likely positive effect with respect to the emissions of air pollutants.

**Principle 8:** *The production of biomass must contribute towards local prosperity.*
Overall farmers are likely to create extra income by e.g. selling Candlenut shells as fuel and especially by Castor Beans oil as biofuel feedstock. Since most of the planted areas are owned by the farmers, the profits for these products will be beneficial to these farmers and thus directly contributing towards local prosperity.

**Principle 9:** *The production of biomass must contribute towards the social well-being of the employees and the local population.*
Since the project is not drastically affecting the existing situation, the negative effects with respect to the social well-being are expected to be negligible. On the contrary, the project is incorporating different efforts that are focussed on contributing to social well-being of the local population.
5. Lessons learned

Main lessons learned throughout the implementation of the project include:

**Project Planning:**
- The partners could have better anticipated the possibility of political change which entailed the introduction of subsidies on LPG, affecting the commercial viability of the castor bean oil supply chain.
- An inception period to bring all partners up to speed would have been beneficial.

**Project implementation:**
- Acceptance by local government and communities has been essential to the project success, particularly regarding the establishment of candlenut nurseries in Lombok. Candlenut is proving a very successful multipurpose tree. Historically Candlenut was being cut down for timber as there was less value in it standing. The project has added value and is facilitating it’s recognition by local government as a ‘priority’ tree for - rehabilitation/conservation. The project has helped raise the profile by planting candlenut as part of community-based agroforestry systems in lands critical for watershed protection, which have been degraded. It is in line with government watershed -management programmes, but is also, unlike many restoration trees accepted by communities since they derive benefits for many years once the canopy has closed without the need to cut the tree down. An additional ecosystem service that was identified and unintended is that local beekeepers in one area are keen to move their hives to areas with candlenut since the flowers are attractive to the honey bees
- The biomass supply must be fit for purpose (high grade quality, clean, loadable), in sufficient volume, ready for timely delivery and competitively priced compared with the unsustainable alternatives. Success of a biomass feedstock for tobacco curing may hinges on differences in price of only a couple of 100-200 rupiah/ kg and also the labour required for feeding the burners 24 hours a day for 5 days.
- Having secure demand is beneficial and gives confidence to developing the supply side. The project has provided PT ELI with an energy alternative that meets the British American Tobacco group policy on fuel wood use. Therefore the local operating company has now chosen the direction to support the use of sustainable biomass for tobacco curing. This demand for sustainable biomass has also encouraged STC to provide alternative stable supplies – palm oil kernel shells from RSPO certified mills in Kalimantan. This result is even more powerful, because at the start of the project PT ELI were initially concerned that the approach may not be technically viable and competitive with other fuel sources. The need for the project to adapt to real world dynamics was essential, this required good communication with the donor and their understanding to make changes within the project. One example, is that given the changed focus to the domestic market it no longer added value to the project or project recipients to pursue RFA certification. Logistically it was not cost-effective and logistically challenging to certify such a dispersed supply base. The domestic market still needs confidence that biomass should come from sustainable sources, however, RFA was not the best way for the project to give this reassurance. The establishment of the Association provides some reassurance, as well as assessments by ECN and also the nature of community agro-forestry system being promoted. In
retrospect, however, a better analysis of the certification options could have been considered during project planning. Indeed the costs and timings of any certification both in establishment and post project should be properly considered. Not just the costs of assessment itself but also for preparation of relevant data and any improvement activities that need to be undertaken to conform with certification requirements.

- One of the biggest challenges of providing a secure supply of biomass is transportation. Even though the production of the biomass may be quite high, not all of the production could be accessed because of the high cost of transportation on Lombok Island. This is mainly caused by bad road infrastructure and the remote locations. One potential way to overcome this is some kind of densification process (i.e., briquetting) done at the original source of supply or farmers could do the processing at one centralised area in a group.

- The project helped farmers to establish a cooperative and an association as a business venture for the farmers to sell their product to get a better price for what they have produced. The original idea is that the cooperative will buy the product from the farmers and sell it to the end market directly as a means to cut off intermediaries. However, as with any other business, the party that invests more of their money will get more benefit. And, at this time, farmers or the cooperative lack funds for investment. The farmers want the money as soon as they sell the product, meanwhile the cooperative do not have the money to pay the product in advance because they have to sell the product first. Therefore, funding to help to start the cooperative is needed.

- Moisture content (MC) really needs to be taken into account. When the biomass is bought in its raw form, the moisture content is usually very high and when it is ready to be used as fuel up to 15% or more of the MC can be lost depending on the product. This loss in moisture content really affects the cost structure of the biomass as fuel. The MC content also determines in what measurement unit the biomass is bought or sold. If the MC content is very high buying by weight is not a good idea because if it will be sold when the biomass is dry enough, then the loss is consider a cost. Buying the biomass in unit size like per bag or per cubic meter is another option when buying or selling biomass fuel, instead of using weight as other fuel. During the course of the project, the selling trends for candlenut shells shifted from per bag to per kg as farmers felt there was less risk involved therein.

- Conversions from fossil fuel to biomass fuel also raise the question about fuel consumption and the total cost that farmers have to pay. The project is working mostly with tobacco farmers, and the tobacco harvest seasons only happen once a year for three months. The first year of the project was spent to convince all the parties involved that biomass could replace other unsustainable fuel and provide the same level of performance and economic viability.

- In the second year of the project the project team calculated the economics of using candlenut shells. The cost of burning candlenut shell was compared against the cost of using other fuels (including coal, fire wood, palm kernel shells, kerosene), the cost compared not just the direct cost of the fuel, but also the indirect cost of the fuel (i.e. investment in equipment, labour cost and others) which are also factors in choice over fuel usage. At the time of the survey, candlenut shells used alone or as a mix with other fuels compared competitively.
6. Follow up of the project

The pilot has stimulated confidence in supply and demand for sustainable biomass and candlenut in particular. STC are currently exploring the commercial financing opportunities for scaling up. STC assess the project as bearing potential to operate on a sound commercial basis. A business plan has been developed for distributing gasifiers to tobacco farmers, and providing them technical services and feedstock. In addition, PT ELI and others in the industry are providing greater demand for biomass.

In order to meet the high demand for biomass feedstock in the mid- and long run, STC see potential in sourcing other biomass species, including fast growing tree species and rice husk. One tobacco company had prior to the project already opted for fast-growing tree species which has stimulated supply. PT ELI are trialling rice husk for curing, but it is too early to judge its potential in the Lombok context.

Besides the still increasing demand for candlenut biomass from PT ELI, there is also a demand from ELI for palm oil kernel shells (POKS). STC as distributing contractor for the project is able to add this biomass stream to the candlenut stream by sourcing from a RSPO certified mill in Kalimantan. This will provide substantial input and stability to the biomass supply chain in Lombok. Through this, sustainable biomass and the importance of acquiring biomass from a certified sustainable source can be seen. It remains a challenge though, to acquire working capital to pre-finance feedstock. For candlenut there are still challenges regarding volume which makes it less reliable than POKS but with potential for increasing supply with more investment. For both POKS and candlenut transportation costs and timings of supply can be limiting. Particularly, if the price of candlenuts and POKS is not competitive with other more immediately available fuel sources, such as unsustainable wood, then they will not be popular for tobacco curing.

FFI will continue to contribute to the establishment of sustainable supply chains and activities through which it can contribute to the further protection of endangered forests and watersheds in Indonesia. To that end, the lessons learned provide a valuable basis for future activities for which broad support and consensus from different stakeholders (including government, private sector, NGOs, etc) ensures sustained results while benefitting people and the environment.
Colophon

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