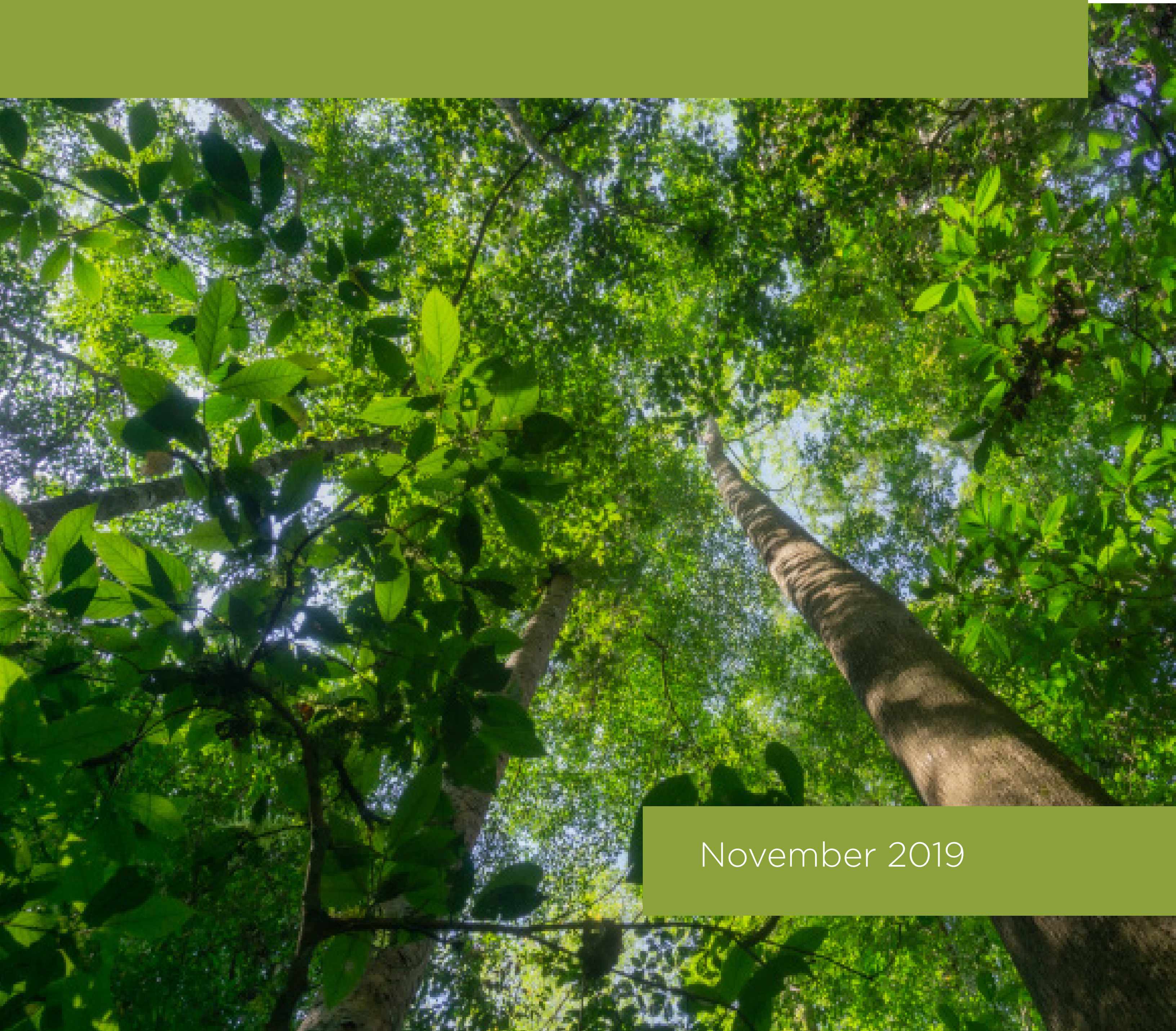
CONSERVATION INTERNATIONAL

Building Out a Toolkit for Restoration: Economic Assessments from Peru, Indonesia and Cambodia



November 2019

FINAL REPORT

November 2019

Building out a Toolkit for Restoration: Economic Assessments from Peru, Indonesia and Cambodia

Pedro Gasparinetti
Diego Brandão
Edward V. Maningo
Dul Ponlork
Azis Khan
Adi D. Bahri
France Cabanillas
Jhon Farfan
Fracisco Roman

All Photos: Shutterstock.com
Design: Caity Pinkard
Service Agreement Number: 6005424

The views expressed in this publication are those of the author(s) and do not necessarily reflect views of Conservation Strategy Fund or its sponsors. Unless otherwise stated, copyright for material in this report is held by the author(s).

Conservation Strategy Fund would like to thans Nikola Alexandre for his supervision and guidance, Conservation International's offices in Peru, Indonesia and Cambodia for their technical support, Camila Daminello for working with our partners, Victor Araújo for technical support, and all of the land restorers we interviewed that kindly provided the information that made this work possible.

CONSERVATION INTERNATIONAL

INDEX

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

This study is intended to be a "Restoration Toolkit:" a record of restoration models with key information on investment costs and benefits based on real case studies from three countries: Peru, Indonesia, and Cambodia. The study discusses alternative restoration methods for these countries, their potential challenges, and opportunities related to economic returns, local regulations and policies, and technical capacities. The literature on forest restoration costs and benefits is still limited for Peru, Cambodia and Indonesia. Consequently, the models here may serve as the first economic records of forest restoration initiatives in these countries.

Each of the models selected in this study had to follow three main criteria: (i) to provide long-term, sustainable gains to the regional ecosystems; (ii) to generate positive economic returns to the necessary investors; and (iii) to be scalable and practical to implement at the local level (with respect given to the technical, political, economic and social factors of each country).

The models were developed based on data collected in the field from actual initiatives, combined with projections about how the models could be developed, adapted, and scaled up in the long term to yield better economic results. This means, for example, that costs related to technical assistance and family labor, which might not have been necessary on the actual properties visited, were also included in cases in order to make the cases replicable.

The data is synthesized and described by key variables, such as: biome; property area (size); main productive activity; biophysical conditions (slope, soil); restoration model; list of species used; initial investment required; investment per hectare; net present value (NPV); internal rate of return (IRR); enabling factors and bottlenecks; technical capacity availability; logistics; regulation and law enforcement. We expect this toolkit to provide valuable insight on the following areas: implementing restoration initiatives, supporting decision-making processes, prioritizing investments that are economically viable and ecologically beneficial, attracting private investments, and generating income to local communities.

The selected cases show that restoration models were implemented in degraded and underused areas. Farmers and restorers tend to prefer to use species with economic potential combined with non-commercial native species for ecological purposes. However, field restoration models were implemented without a prior economic assessment, as these models were still in the beginning stages.

The study demonstrates how differences in the original state of the soil are an important factor in determining the restoration model's economic feasibility. Additional investments are necessary in places with poor soil conditions. However, degraded areas with fertile soil not only require less investment, but also present higher productivity. Therefore, restoration models that demand lower investments due to soil conditions can be economically promising, while models with higher initial investments tend to be less economically feasible (such as in the case of Cambodia).

There are similarities in the profiles of stakeholders involved with forest restoration in the different countries. The study indicates that there is a strong participation of non-governmental organizations in partnership with rural producers. Non-governmental organizations tend to subsidize investments aimed at ecological, rather than economic, gains. The governments operate mainly in protected areas without economic objectives and often support the partnership between non-governmental organizations and rural producers.

In addition, it was shown that there are different legal issues related with forest restoration in the profiled countries. Local legislation often does not clearly detail the percentage of land that should be conserved or restored on each property, or the accepted combination of native and exotic species that might be used for that objective. Thus, because of the lack of legal definitions, forest restoration in these countries is often carried out on a voluntary basis or incentivized by non-governmental projects. In other cases, such as in Indonesia, the government has clearer restoration targets and policies that might incentivize restoration initiatives.

Finally, the studies have indicated that landowners and communities, in general, are inexperienced in conducting forest restoration. Thus, a potential large-scale action plan would depend heavily on the provision of technical assistance, essential for this kind of initiative to evolve successfully.

The report is organized as follows: The first chapter is a summary of the results from the three countries, discussing financial results, enabling factors, challenges, and differences and similarities among countries. The following chapters present the in-depth descriptions for each country's contexts and results. These core chapters are developed as follows: (i) a literature review on potential restoration models for the regions; (ii) a discussion of the local context and the characteristics of landowners that could be engaged in restoration initiatives; (iii) a discussion on the selection of the most promising restoration models from an economic perspective; (iv) the economic assessment of the two restoration cases, plus a seeds dispersion model; (v) a discussion on enabling factors and bottlenecks for economic restoration in the selected region; and (vi) final remarks.

SUMMARY OF RESULTS

Regional Context and Characterization of the “Standard Restorers”

In Peru, Indonesia and Cambodia the demand for forest restoration is mainly associated with agricultural degradation and illegal logging. In Peru, the main causes of deforestation are associated with the expansion of coffee, cocoa, rice, livestock, illegal felling and land trafficking. In Indonesia, particularly in North Sumatra, the rapid expansion of palm oil extraction has been cited as the main threat to long-term natural forests. In Cambodia, deforestation is currently related to illegal logging and the expansion of agriculture.

There is a similarity in the profile of agents involved with forest restoration in the different countries. There is a strong participation of non-governmental organizations in partnership with rural producers. Non-governmental organizations tend to subsidize investments aimed at ecological rather than economic results. On the other hand, governments act by creating legal provisions and support initiatives between non-governmental organizations and farmers.

Non-governmental forest restoration organizations include, Conservation International, World Wildlife Fund (WWF), and United Nations Development Program (UNDP). In general, non-governmental organizations partner with farmers and community members to implement experimental initiatives in areas smaller than 10 hectares. The state, in turn, is primarily responsible for forest restoration in areas protected by law. In Indonesia, the state still grants degraded areas for private economic use, but without an ecological purpose.

Selection of Restoration Models

Nine forest restoration models were selected, three for each country, with two for economic and ecological purposes, and one only for ecological purposes (seeds dispersion method) (Table 1). The basic assumption of this selection is that the nine models fulfill ecological functions and are better land-use alternatives for degraded areas. These models are described in detail below. More detailed information on these forest restoration models can be obtained from the original documents.

Economic Assessment of Forest Restoration Models

For each country and region, we found three restoration models that meet the objective of this assignment.

Table 1 - Restoration Models Area and Species

Models		Area (ha)
Peru		
1	Cacao and silvopastoral (with native and exotic trees)	5.8
2	Coffee, cacao, guaba and jacaranda	3.0
3	Seed dispersal	1.0
Indonesia		
4	Sea cypress and ketapang	2.0
5	Durian, mangosteen and coconut	2.0
6	Seed dispersal	1.0
Cambodia		
7	Turmeric, ginger and lemon grass as forest farming crops	1.0
8	Rattan and Bamboo as forest farming crops	1.0
9	Taungya	1.0

Cases from Peru

The selected models in Peru are variations of agroforestry models, based on native perennial species with annual harvests, such as cacao and coffee. It is important to highlight that the soil conditions for the selected models were very favorable, demanding little investment to enrich or correct its composition, also yielding good production. Other examples with more degraded soil were found, demanding larger investments and having worse productivity, which led to unfeasible economic results.

Model 1 - Peru: Cacao and silvopastoral (native and exotic trees)

This model was based on a property located in the Gepelacio District, Moyobamba Province, San Martin Department. The area has an extension of 17.5 hectares and was previously dedicated to agriculture and livestock. The site has an inclined topography of approximately 45°, and therefore, erosion is more likely to cause problems in the area. Based on the owner's previous bad experiences, and with the help of CI technicians, a silvopastoral system[1] of 0.75 ha was implemented in order to prevent soil erosion. It consists of species of economic and ecological importance such as: Pino Chuncho (*Schizolobium amazonicum*), Bolaina (*Guazuma crinita*), Capirona (*Calycophyllum spruceanum*) and Shaina (*Colubrina glandulosa*) and introduced species such as the Cedro de la India (*Acrocarpus fraxinifolius*). They were planted at a distance of 4m x 4m, resulting in 468 plants, associated with cattle grass (*Brachiaria brizantha*). They have also planted cocoa (monoculture) on 5 hectares at a distance of 3m x 3m, in another plot.

Figure 1 - The Silvopastoral System with 5 forest species of ecological relevance

The agroforestry system was implemented for economic purposes, so that the owner could have an income and pay for the costs generated by the restoration. Furthermore, he planned to plant some timber plants within the system, so that they could cover in the area once the cycle of cocoa is completed.

[1] The economic results considered only the production from trees - therefore cattle breeding is not included in the analysis.

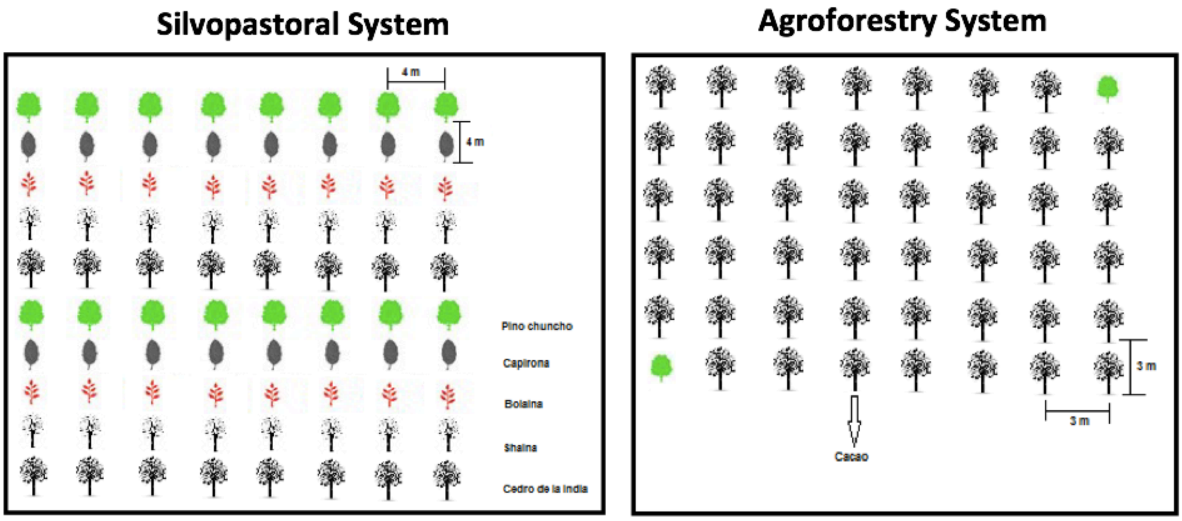


Figure 2 - Sketch of Model 1: On the left the Silvopastoral System with 5 species of ecological importance, on the right the Agroforestry System with Cocoa.

The annual production yield of the 5 hectares increases from Year 3 to Year 8. Also, the income stabilizes from Year 9 to Year 30, due to cocoa’s maximum production (average annual production of 5 hectares is 3750 kg). The price is USD 2.12 per kg. The simplified cash flow is presented in the following table:

Table 2 - Cash flow of Model 1 – Peru - Cocoa

YEAR	Gross Revenue	Tax on Sales	Cost & Investments	Cash Flow before income tax	Tax on Income	Cash Flow after taxes
1	-	-	2,600.0	- 2,600.0	-	- 2,600.0
2	-	-	783.0	- 783.0	-	- 783.0
3	212.0	-	1,200.0	- 988.0	-	- 988.0
4	1,060.0	-	1,201.5	- 141.5	-	- 141.5
5	2,120.0	-	1,201.5	918.5	-	918.5
6	4,240.0	-	1,201.5	3,038.5	-	3,038.5
7	6,360.0	-	1,201.5	5,158.5	-	5,158.5
8	7,950.0	-	1,201.5	6,748.5	-	6,748.5
9	7,950.0	-	1,588.5	6,361.5	-	6,361.5
10	7,950.0	-	1,588.5	6,361.5	-	6,361.5
11	7,950.0	-	1,588.5	6,361.5	-	6,361.5
12	7,950.0	-	1,588.5	6,361.5	-	6,361.5
13	7,950.0	-	1,588.5	6,361.5	-	6,361.5
14	7,950.0	-	1,588.5	6,361.5	-	6,361.5
15	7,950.0	-	1,588.5	6,361.5	-	6,361.5
16	7,950.0	-	1,588.5	6,361.5	-	6,361.5
17	7,950.0	-	1,588.5	6,361.5	-	6,361.5
18	7,950.0	-	1,588.5	6,361.5	-	6,361.5
19	7,950.0	-	1,588.5	6,361.5	-	6,361.5
20	7,950.0	-	1,588.5	6,361.5	-	6,361.5
21	7,950.0	-	1,588.5	6,361.5	-	6,361.5
22	7,950.0	-	1,588.5	6,361.5	-	6,361.5
23	7,950.0	-	1,588.5	6,361.5	-	6,361.5
24	7,950.0	-	1,588.5	6,361.5	-	6,361.5
25	7,950.0	-	1,588.5	6,361.5	-	6,361.5
26	7,950.0	-	1,588.5	6,361.5	-	6,361.5
27	7,950.0	-	1,588.5	6,361.5	-	6,361.5
28	7,950.0	-	1,588.5	6,361.5	-	6,361.5
29	7,844.0	-	1,588.5	6,255.5	-	6,255.5
30	7,844.0	-	1,588.5	6,255.5	-	6,255.5

Table 3 - Cash flow of Model 1. Installation, management, harvest and sales of Cocoa plantation

Operation	**Costs during X years (USD)**	**Cost per hectare**
Initial investment activities	USD 452.00	Purchase cocoa seeds (USD 24.00) Purchase of seedlings (USD 30.00); Installation and maintenance of temporary nursery (USD 54.00) Land preparation (USD 36.00) Plantation (USD 72.00) Technical assistance (USD 20.00) Weeding (USD 216.00)
Maintenance activities	USD 150.00	Weeding and preparation (USD 85.00) Fertilization (USD 18.00) Pruning management (USD 47.00)
Harvest & sale activities	USD 1,754.00	Harvest 750 kg (USD 120.00) Dry 750 kg (USD 44.00) Sales 750 kg (USD 1,590.00)
TOTAL	USD 2,356.00	

The costs considered in table 3 are for an initial investment and maintenance, harvest and sales of 1 hectare of cocoa plantation throughout the life of the crop.

The investment for this area was $ 2,600.00, with an IRR of 40% and an NPV of $ 15,552.00. For this reason, the financial indicators show that this restoration model is feasible under the established parameters. Also, this model doesn't include the livestock profits, which could increase the viability of this project.

Table 4 - Financial indicators of Model 1 – Perú – Cacao and Silvopastoral

Item	Value (USD)
Area (hectares)	5.8
Investment	2,600
Investment/ha	452
IRR	40%
NPV	15,552
NPV/ha	2,705
Benefit/Cost ratio	2.6

In the Alto Mayo Basin, there are areas with flat or sloping topographies, typical of a high forest. In some cases, there are species that need certain conditions, such as high altitude, higher humidity and precipitation, soils rich in organic matter, among others. These may alter investment costs when implementing a restoration plot.

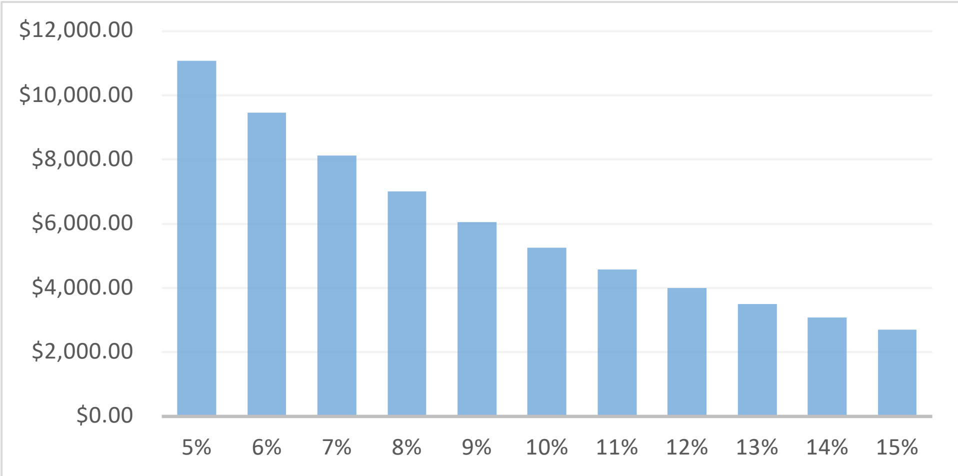


Figure 3 - Sensitivity Analysis – NPV/ha x Discount Rate – Model 1 – Cacao and Silvopastoral

Model 2 - Peru: Coffee, cacao, guaba and jacaranda

This model was based on a property located in the District of Calzada, Moyobamba Province, San Martin Department. It has a total area of 3.5 hectares and, 30 years ago, was dedicated to agriculture. However, it now has the capacity to produce its own seedlings, compost and fertilizers. The owner has been managing 2.5 hectares of coffee (*Coffea arabica*), grown with Guaba (*Inga edulis*) plants to provide shade to Coffee plantation and 0.5 hectares of cocoa planted with jacaranda trees (*Jacaranda copaia*) that grew on a natural regeneration process. Initially, 6,250 coffee seedlings were planted on 2.5 hectares at a distance of 2m x 2m, with guaba, for permanent shade at a distance of 5m x 5m. Cocoa has been planted at a distance of 3m x 3m and it is combined with jacaranda trees that grew naturally, due to the dispersion of seeds from neighboring forests to the area.

The restoration model of cocoa and jacaranda showed over time that the association of both species is interesting, proving to be beneficial for both of them, since the coca plants needs shade in the first two years of the cycle, and this shade is provided by Jacaranda. In addition, jacaranda is a fast-growing native species of important ecological value, since it is an important resource to many wildlife species.

The annual production yield of this plot is similar to Model 1. The production increases from Year 3 to Year 10. It then stabilizes from Year 11 to Year 30, with an average annual production of 400 kg in ½ hectare. The price is the same as indicated in Model 1 ($ 2.12 per kg).

Agroforestry System – Part 1

(Coffee + Guaba)

Agroforestry System – Part 2

(Cocoa + Jacaranda)

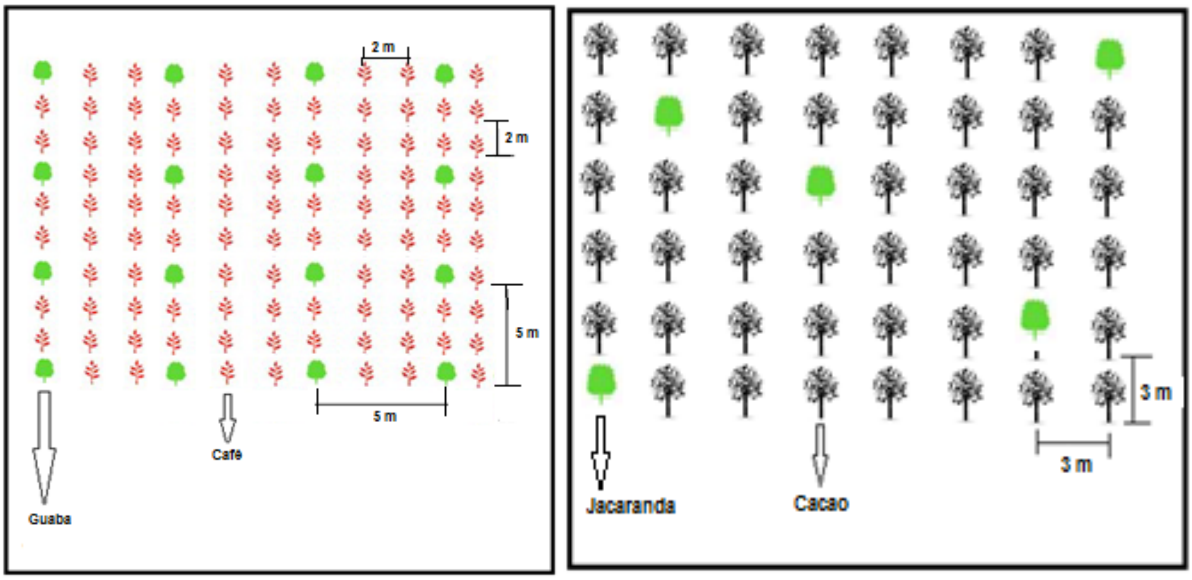


Figure 4 - Sketch of Model 2. On the left, the Coffee and Guaba system, and on the right the Cocoa and Jacaranda system.

The simplified cash flow is presented in the following table:

Table 5 - Cash flow of Model 2 – Peru - Coffee and Cocoa

YEAR	Gross Revenue	Tax on Sales	Cost & Investments	Cash Flow before income tax	Tax on Income	Cash Flow after taxes
1	-	-	620.0	-620.0	-	-620.0
2	1,095.0	-	859.0	236.0	-	236.0
3	1,502.4	-	1,003.0	499.4	-	499.4
4	1,931.0	-	1,553.0	378.0	-	378.0
5	2,767.0	-	1,258.0	1,509.0	-	1,509.0
6	2,979.0	-	1,247.0	1,732.0	-	1,732.0
7	3,191.0	-	1,265.0	1,926.0	-	1,926.0
8	3,297.0	-	1,274.0	2,023.0	-	2,023.0
9	3,360.6	-	1,274.0	2,086.6	-	2,086.6
10	3,403.0	-	1,274.0	2,129.0	-	2,129.0
11	3,403.0	-	1,274.0	2,129.0	-	2,129.0
12	3,403.0	-	1,274.0	2,129.0	-	2,129.0
13	3,403.0	-	1,274.0	2,129.0	-	2,129.0
14	3,403.0	-	1,274.0	2,129.0	-	2,129.0
15	3,403.0	-	1,274.0	2,129.0	-	2,129.0
16	3,403.0	-	1,274.0	2,129.0	-	2,129.0
17	3,403.0	-	1,274.0	2,129.0	-	2,129.0
18	3,403.0	-	1,274.0	2,129.0	-	2,129.0
19	3,403.0	-	1,274.0	2,129.0	-	2,129.0
20	3,403.0	-	1,274.0	2,129.0	-	2,129.0
21	3,403.0	-	1,274.0	2,129.0	-	2,129.0
22	3,403.0	-	1,274.0	2,129.0	-	2,129.0
23	3,403.0	-	1,274.0	2,129.0	-	2,129.0
24	3,403.0	-	1,274.0	2,129.0	-	2,129.0
25	3,403.0	-	1,274.0	2,129.0	-	2,129.0
26	3,403.0	-	1,274.0	2,129.0	-	2,129.0
27	3,403.0	-	1,274.0	2,129.0	-	2,129.0
28	3,403.0	-	1,274.0	2,129.0	-	2,129.0
29	3,403.0	-	1,274.0	2,129.0	-	2,129.0
30	3,403.0	-	1,274.0	2,129.0	-	2,129.0

Table 6 - Cash flow of Model 2 - Coffee and Cocoa

Operation	Costs during X years (USD)	Cost per hectare (Café y Cacao)	
Initial investment activities	USD 1,240.00	Purchase of coffee seeds (USD 30.00) Purchase of guaba seeds (USD 40.00) Purchase of cacao seeds (USD 30.00) Purchase and application of fertilizers (USD 180) Installation and maintenance temporary nursery (USD 306.00) Land preparation (USD 32.00) Plantation (USD 72.00) Technical advice (USD 240.00) Weeding (USD 144.00)	
Maintenance activities	USD 519.00	Weeding and preparation (USD 360.00) Technical advice (USD 60.00) Fertilization (USD 27.00) Pruning management (USD 72.00)	
Harvest & sale activities	USD 1,705.00 en Café USD 1,719.2 en Cacao	Harvest 20 Quintales of coffee (USD 200.00) Dried out of 20 Quintales of coffee (USD 45.00) Sales of 20 Quintales of coffee (USD 1,460.00) Harvest - 760 Kg cocoa (USD 72.00) Dried out - 760 Kg cocoa (USD 36.00) Sales of 760 kg cocoa (USD 1,611.20)	
TOTAL	$ 5,183.20		

The costs considered in table 6 represents the initial investment and maintenance costs, harvest and sales of 1 hectare of coffee and cocoa plantations throughout the plant cycle. (01 quintal =100 Kg)

The site visited is reported to have fertile soil, and low input costs, such as labor (USD 9/day) and seedlings (USD 1 each), which is cheaper than purchasing seeds. Therefore, the initial investment costs are low, and productivity is high. The relatively low installation cost of

$620.00 generates an NPV of USD 2,494 per hectare in 30 years, indicating its highly profitability[2].

Table 7 - Financial indicators of Model 2 - Peru – Coffee & Cocoa

Item	Value (USD)
Area(hectares)	3.0
Investment	620
Investment/ha	207
IRR	88%
NPV	7,482
NPV/ha	2,494
Benefit/Cost ratio	5.9

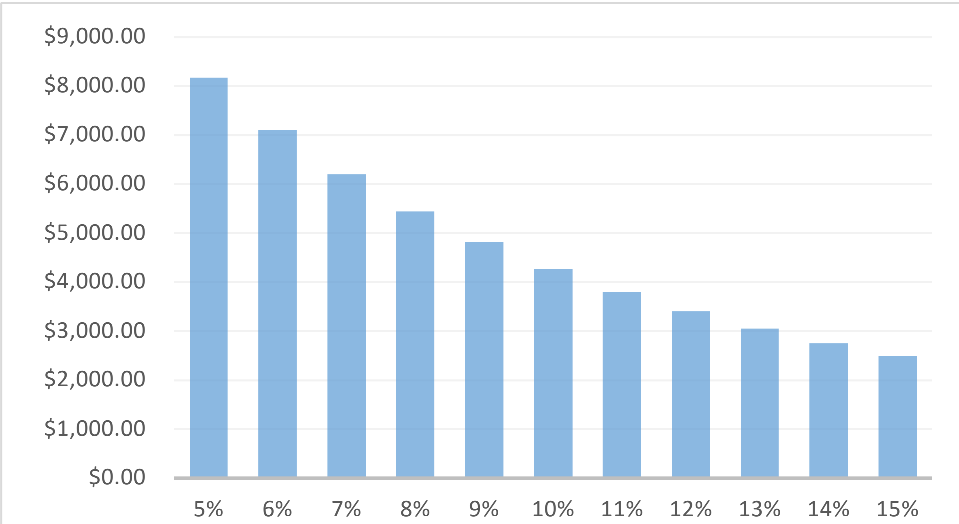


Figure 5 - Sensitivity Analysis – NPV/ha x Discount Rate – Model 2 – Peru – Coffee & Cocoa

Model 3 - Peru: Seed dispersal

This model was designed only for ecological purposes, therefore profitable species were not included. This model was based on a 5-hectare property and a discount rate of 15%. The highest costs are related to planting and maintenance, since the management of the seeds lasts until Year 3. The total cost for the restoration of 5 hectares is about USD 3,350 (USD 2,240 for installation and USD 1,110 for maintenance), resulting in a total cost of USD 670 per restored hectare (including maintenance).

---

[2] We also visited another coffee plantation (Coffee arabica) associated with Guaba (*Inga edulis*), similar to Model 2, with the same spacing of coffee and guaba. This property had an area of 1 hectare, where the owner added 60 plants of Tornillo *(Cedrelinga catenaeformis)* and 40 Sinami *(Oenocarpus mapora)* in a dispersed way.

Table 8 - Costs of Model 3 – Peru - Seed dispersal – 5ha

N°	Components	Price (USD)
1	Seeds (1000 x @ USD 1.00)	1,000.00
2	Inputs and tools	480.00
3	Planting and maintenance	1,710.00
4	Technical assistance	160.00
	TOTAL COST	3,350.00

Cases from Indonesia

The selected models in Indonesia are divided by two different focus landscapes: lowlands and highlands. Lowlands encompass coastal and peatland areas. In highlands, the proposed restoration model seeks to tackle issues related to the main degradation driver in the country – the expansion of the palm oil industry. Here we present the models with what is considered to yield the greatest ecological gains and diversity. In the following chapter that details the local context, variations of the models that also proposes, for example, enriching palm trees areas with other species, are also presented.

Model 1 – Indonesia, Lowland: Coconut, Ketapang and Cemara Laut

The lowlands restoration model is a combination of native sea cypress (*Casuarina equisetifolia*) and ketapang (*Terminalia catappa*). The restoration is done in two ecosystems: coastal and peatland areas. This model targets the protection of endemic species, especially penyu belimbing (*Dermochelys coriacea*)[3], a native turtle. The model is outlined under a local village regulation (Peraturan Desa)[4] that regulates areas 100m towards the mainland (which is calculated from the shoreline during tides session) are classified as protected areas. The first 50 meters from the shoreline is restrict to general activities, except for those related to turtle management. The remaining 50m are authorized to be managed by the community for agricultural activities. It is common to cultivate coconut trees, cemara laut or sea cypress (*Casuarina sp*p.), species that are planted close to each other in this area. The 2nd 50 m part with agriculture is primarily aimed to guard the 1st 50 m and also to fortify large waves and seawater abrasión.

This model attempts to restore the peatland that is threatened by palm oil plantations, back to its natural condition, as a mechanism for water management and carbon sequestration. Under this scenario, the oil palm, that must be cut down at the end of its natural cycle, generally 20-25 years, could be replaced by native species under this agroforestry system and be used as a restoration alternative to recover the peatland ecological functions.

Palm trees is planted by companies (mostly) and communities (a small portion). The age of palm tree is 5 years and 12 years. Not all community lands have been planted with palm tree. The restoration will be carried out on community land and coastal land (under a local village regulation). The planting method in this model can be done either with or without shade at the initial phase, for the three species. Planting is done after the oil palm has been removed. As shown in the sketch below, the planting distance between the coconut seedlings is about 15m x 15 m resulting in 44 coconut trees per hectare. Native plants are arranged in a way that form plant rows or windbreaks, between cocunt plantations, Communities have done it/activity.

---

[3] Of the 7 types of sea turtles in the world, 6 species are in Indonesia, 5 species can be found on the coastal area of Muara Upu. (https://rakyatsumutnews.com/2019/04/25/5-jenis-penyu-kekayaan-hayati-pantai-muara-upu/) retrieved July 30 2019

[4] Peraturan Desa Muara Upu No. 01/2015 – a village regulation regarding Muara Upu Marine and Coastal Management

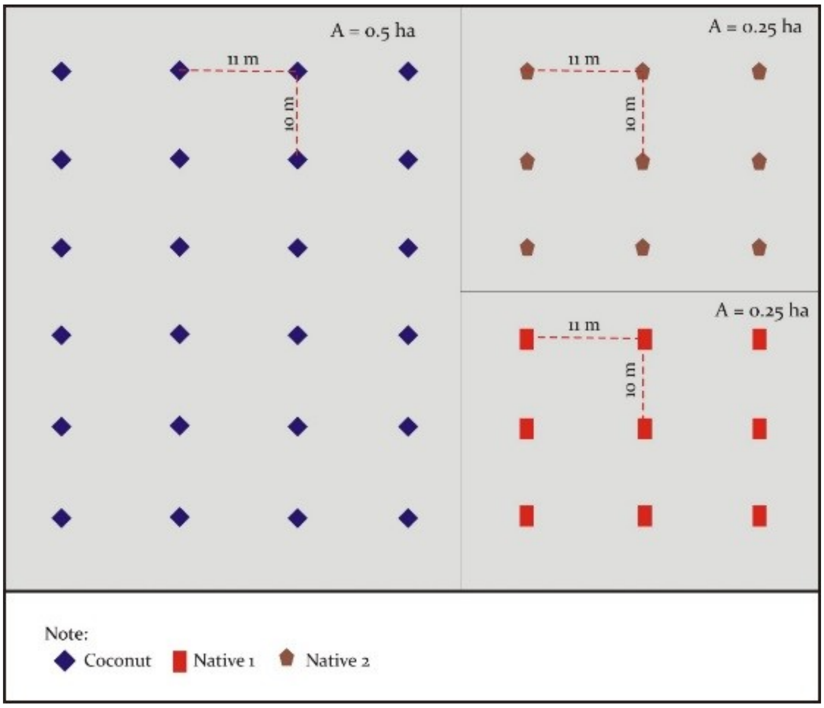


Figure 6 - Sketch of Model 1 – Indonesia - Sea cypress and ketapang

The simplified cash flow is presented on the following table:

Table 9 - Cash flow of Model 1 – Indonesia – Coconut, Ketapang and Cemara Laut

Year	Gross Revenue	Tax on Sales	Cost & Investments	Cash Flow before income tax	Tax on Income	Cash Flow after taxes
1	-	-	208.3	-208.3	-	-208.3
2	-	-	45.5	-45.5	-	- 45.5
3	-	-	45.5	-45.5	-	- 45.5
4	105.6	10.6	37.2	57.8	1.4	56.4
5	116.2	11.6	55.2	49.4	1.2	48.1
6	147.8	14.8	57.8	75.2	1.9	73.4
7	190.1	19.0	61.3	109.7	2.7	107.0
8	211.2	21.1	63.1	127.0	3.2	123.8
9	211.2	21.1	63.1	127.0	3.2	123.8
10	211.2	21.1	63.1	127.0	3.2	123.8
11	211.2	21.1	63.1	127.0	3.2	123.8
12	211.2	21.1	63.1	127.0	3.2	123.8
13	211.2	21.1	63.1	127.0	3.2	123.8
14	211.2	21.1	63.1	127.0	3.2	123.8
15	211.2	21.1	63.1	127.0	3.2	123.8
16	211.2	21.1	63.1	127.0	3.2	123.8
17	211.2	21.1	63.1	127.0	3.2	123.8

Year	Gross Revenue	Tax on Sales	Cost & Investments	Cash Flow before income tax	Tax on Income	Cash Flow after taxes
18	211.2	21.1	63.1	127.0	3.2	123.8
19	211.2	21.1	63.1	127.0	3.2	123.8
20	211.2	21.1	63.1	127.0	3.2	123.8
21	211.2	21.1	63.1	127.0	3.2	123.8
22	211.2	21.1	63.1	127.0	3.2	123.8
23	211.2	21.1	63.1	127.0	3.2	123.8
24	211.2	21.1	63.1	127.0	3.2	123.8
25	190.1	19.0	61.3	109.7	2.7	107.0
26	169.0	16.9	59.6	92.5	2.3	90.2
27	147.8	14.8	57.8	75.2	1.9	73.4
28	137.3	13.7	56.9	66.6	1.7	64.9
29	116.2	11.6	55.2	49.4	1.2	48.1
30	105.6	10.6	-	95.0	2.4	92.7
TOTAL	1,260.50		2,226.94			

The assessment results indicate that this model needs an investment of about USD 104.15 per ha, in the first year. Therefore, the model presents an NPV of US$224.50 per ha, over a 30 year period. Also, the IRR of 22.2% implies that the project is financially feasible.

The cost of Model 4 detailed by operation category is shown below .

Table 10 - Cost of Model 1 – Indonesia – Coconut, Ketapang and Cemara Laut

Operation	**Costs during 30 years (USD)**	**Cost per hectare**	
Initial investment activities	178,07	Supplies for seed (durian and palm)	71,25
		Fertilizer for investment in first year	42,66
		Hole digging	18,00
		Labor - planting	46,16
Maintenance activities	1.979,42	Annual (29 year)	68,26
		Fertilizer for second-last year	1.237,14
		Labor for second-last year	742,28
Harvest & sale activities	105,20	Annual (27 year for harvest)	3,90
		Labor for harvest	105,20
TOTAL	2.262,69*		

**No taxes included*

Table 11 - Financial indicators of Model 1 - Indonesia – Coconut, Ketapang and Cemara Laut

Item	Value (USD)
Area(hectares)	2.0
Investment	208.30
Investment/ha	104.15
IRR	22.2%
NPV	449.01
NPV/ha	224.50
Benefit/Cost Ratio	1.66

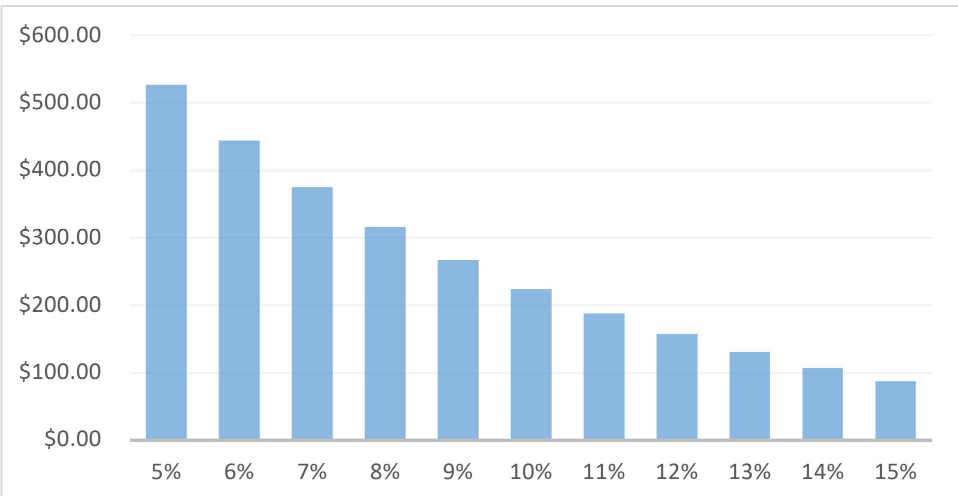


Figure 7 - Sensitivity Analysis – NPV/ha x Discount Rate – Model 1 - Indonesia – Coconut, Ketapang and Cemara Laut

Model 2 – Indonesia, Upland: Durian, Manguis, Coconut

This model consists of three species that were chosen because they are popular in the area and have high economic value in the region of Tapanuli Selatan. In particular, the combination of these species with a native timber could accelerate the development of this model, since they are shade tolerant in the early planting period. This model was designed so that it could be implemented during the palm oil cycle. From Year 5 to Year 10 on, the palm oil trees can be replaced by the three commercial species and the native plants. During the field visit, the palm trees are already 10 and 15 years. Communities could plant the restoration species under the palm trees. After palm trees are 20/25 year old, community could remove it. Costs related to the installation were not included in our economic calculation due to limited data and information.

The plant composition of this model was suggested by the local community during field visits, presented in the sketch below.

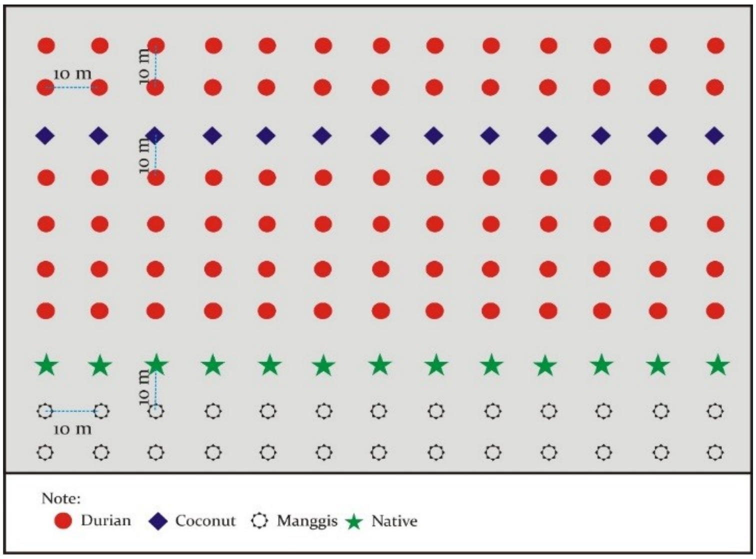


Figure 8 - Sketch of Model 2 – Indonesia - Durian, mangosteen and coconut

The simplified cash flow is presented on the following table:

Table 12 - Cash flow of Model 2 – Indonesia - Durian, mangosteen and coconut

Year	Gross Revenue	Tax on Sales	Cost & Investments	Cash Flow before income tax	Taxon Income	Cash Flow after taxes
1	-	-	434.2	-434.2	-	-434.2
2	-	-	136.5	-136.5	-	-136.5
3	-	-	136.5	-136.5	-	-136.5
4	123.2	12.3	145.3	-34.4	-	-34.4
5	135.5	13.6	146.2	-24.2	-	-24.2
6	172.5	17.2	148.8	6.4	0.2	6.2
7	221.8	22.2	152.4	47.2	1.2	46.1
8	246.4	24.6	154.1	67.6	1.7	66.0
9	547.4	54.7	154.1	338.5	8.5	330.1
10	830.4	83.0	154.1	593.2	14.8	578.4
11	1,131.4	113.1	154.1	864.1	21.6	842.5
12	1,176.4	117.6	154.1	904.6	22.6	882.0
13	1,468.4	146.8	154.1	1,167.4	29.2	1,138.3
14	1,486.4	148.6	154.1	1,183.6	29.6	1,154.1
15	1,787.4	178.7	154.1	1,454.5	36.4	1,418.2
16	1,823.4	182.3	154.1	1,486.9	37.2	1,449.8
17	2,124.4	212.4	154.1	1,757.8	43.9	1,713.9
18	2,292.9	229.3	154.1	1,909.5	47.7	1,861.8
19	2,461.4	246.1	154.1	2,061.1	51.5	2,009.6
20	2,726.4	272.6	154.1	2,299.6	57.5	2,242.2
21	552.4	55.2	108.6	388.6	9.7	378.8
22	1,383.3	138.3	108.6	1,136.4	28.4	1,108.0
23	1,356.8	135.7	108.6	1,112.5	27.8	1,084.7
24	1,277.3	127.7	108.6	1,041.0	26.0	1,014.9
25	1,157.5	115.8	106.8	934.9	23.4	911.5
26	746.2	74.6	59.6	612.0	15.3	596.7
27	653.0	65.3	57.8	529.8	13.2	516.6
28	606.3	60.6	56.9	488.7	12.2	476.5
29	513.0	51.3	55.2	406.6	10.2	396.4
30	466.4	46.6	8.8	411.0	10.3	400.7
TOTAL	5,946.11		6,918.08			

For the first year of restoration, the cost of this model is about USD 217.11 per ha. Thus, the model has an NPV of about USD 1,819.55 per ha, over a 30 year period. The IRR of 26.74%

indicates that this restoration model is financially feasible as it is also confirmed by its Benefit Cost Ratio of 3.13. Compare to regular palm oil plantation in Indonesia, where IRR was about 14,83 during 25 yrs plantation cycle (Svatonova et al, 2015), the IRR of this model is significantly higher. IRR values are very high in just one palm tree species. In some plantation areas such as Sulawesi, the value reaches more than 25% (Defidelwina 2013), and in Sumatra and Kalimantan even more than 500% (eg: Hutabarat 2011, Sarasvati 2018).

The cost of Model 5 detailed by operation category is shown below.

Table 13 - Cost of Model 2 – Indonesia - Durian, mangosteen and coconut

Operation	**Costs during 30 years (USD)**	**Cost per hectare**	
Initial investment activities	164,75	Supplies for seed (manggis and durian)	97,75
		Fertilizer for investment in first year	28,44
		Hole digging	18,00
		Labor - planting	20,56
Maintenance activities	978,34	Annual (2-25 year)	42,54
		Fertilizer for second-last year	611,46
		Labor for second-last year	366,88
Harvest & sale activities		For manggis and durian, the price of fruit	
TOTAL	1.143,09*		

**No taxes included*

Table 14 - Financial indicators of Model 2 – Indonesia - Durian, mangosteen and coconut

Item	Value (USD)
Area (hectares)	2.0
Investment	434.21
Investment/ha	217.11
IRR	26.74%
NPV	3,639.10
NPV/ha	1,819.55
Benefit/Cost Ratio	3.13

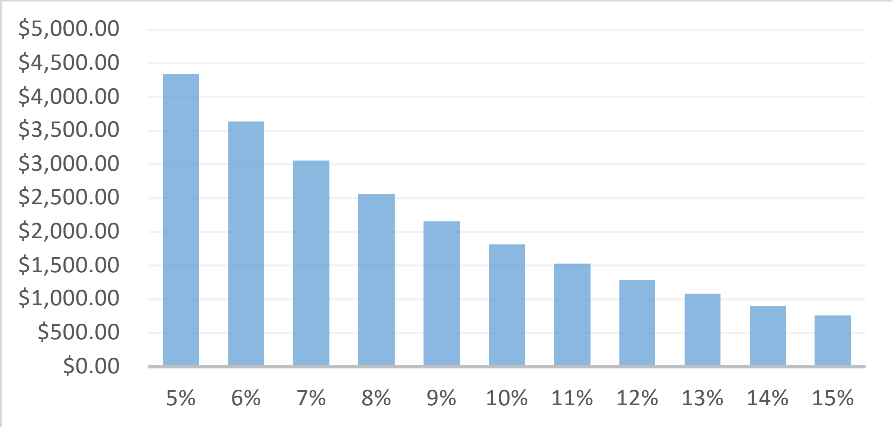


Figure 9 - Sensitivity Analysis – NPV/ha x Discount Rate – Model 2 – Indonesia - Durian, mangosteen and coconut

Model 3 - Seed dispersal model[5]

This model was designed for ecological purposes only, meaning that species with economic value were not included. Moreover, the management of this kind of restoration is simple and does not demand many costs over time.

The implementation of this model (Table 11), however, has several costs. This restoration is presented in a 1-hectare base calculation, with a plant spacing of 4m x 4m (the density is about 625 plants per hectare). The price of the native seeds is USD 2.13 (per seed), similar to Model 5 and 6. Furthermore, the cost of the planting holes is about USD 0.36 per hole, and planting is about USD 0.07 per seed planted. With this, the total cost of this restoration is about USD 1,600.00 per hectare. The assumption, the community will get the seeds by buying it.

Table 15 - Costs of Model 3 – Indonesia - Seed dispersal

Components	Cost (USD/ha)
Seed from native trees (625 x @ USD 2.13)	1,331.25
Hole of native trees (625 x @ USD 0.36)	225.00
Planting native trees (625 x @ USD 0.07)	43.75
TOTAL COST	1,600.00

[5] In Chapter 3, it appears as Model 5.

Table 16 indicates the cost detailed more by category of operation

Table 16 - Cost of Model 3 - Indonesia - Seed dispersal model

Operation	Costs during 30 years (USD)	Cost per hectare	
Initial investment activities	1,600.00	Supplies for seed (native)	1,331.25
		Hole digging	225,00
		Labour - planting	43.75
Maintenance activities	-	Annual (2-29 year)	-
		Fertilizer for second-last year	-
Harvest & sale activities	-	Annual (4-30 year)	-
		Labor for harvest	-
TOTAL	1,600.00		

Cases from Cambodia

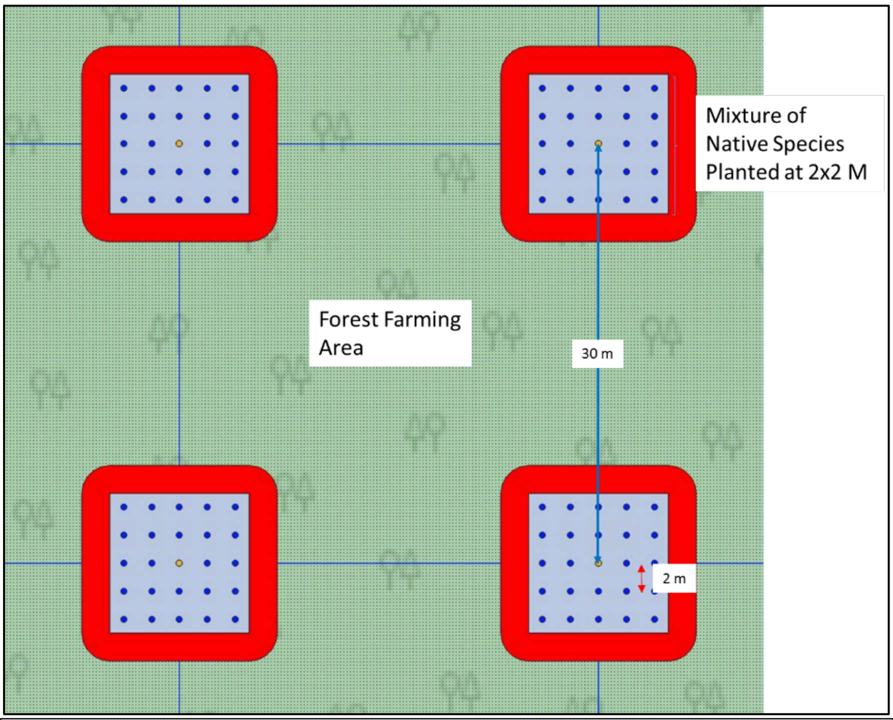
The models selected in Cambodia seek a combination of local traditional agricultural activities with annual crops, combined with restoration using native species with ecological functions. Soil preparation and mechanical hole digging showed to be important cost components that were necessary for the proposed restoration models.

Model 1 - Turmeric, ginger, lemon grass and clusters of native species

This model has two components: (1) clusters for forest restoration and (2) crop/forest farming. Forest restoration involves the planting of timber species to rehabilitate the area, while crop farming is the production and revenue-generation component of the design (ginger, lemon grass and turmeric). In farming, crops with economic value are intercropped underneath the sapling that grows in between the clusters. The site visited is comprised of a mix of early succession deciduous forest. The trees are mostly in the sapling stage with low density. Due to low canopy cover, grasses thrive underneath the trees –the *Shorea obtusa* being the main species.

Enrichment planting is the main approach of the restoration site in Ou Baktra. The site is a degraded second growth forest and remnants of a logged over area. After the forest concession folded up, some people established clandestine farms until the area was covered by a Community Forestry. Thereafter, the forests gradually start to recover. Enrichment planting is implemented in combination with the following planting design and principles: (1) planting in clusters that will serve as plant recruitment points; (2) use of framework species; (3) using a mix of as many species as possible following the Miyawaki technique; and (4) using indigenous species, following the Rainforestation approach. Cluster plots measuring 10m x 10m will be established 30 meters apart and, in each cluster, 25 trees pioneer and climax species will be planted at 2m x 2m as shown below[6].

[6] During the field visit, CARITAS Switzerland had not yet completed the planting in the cluster plots



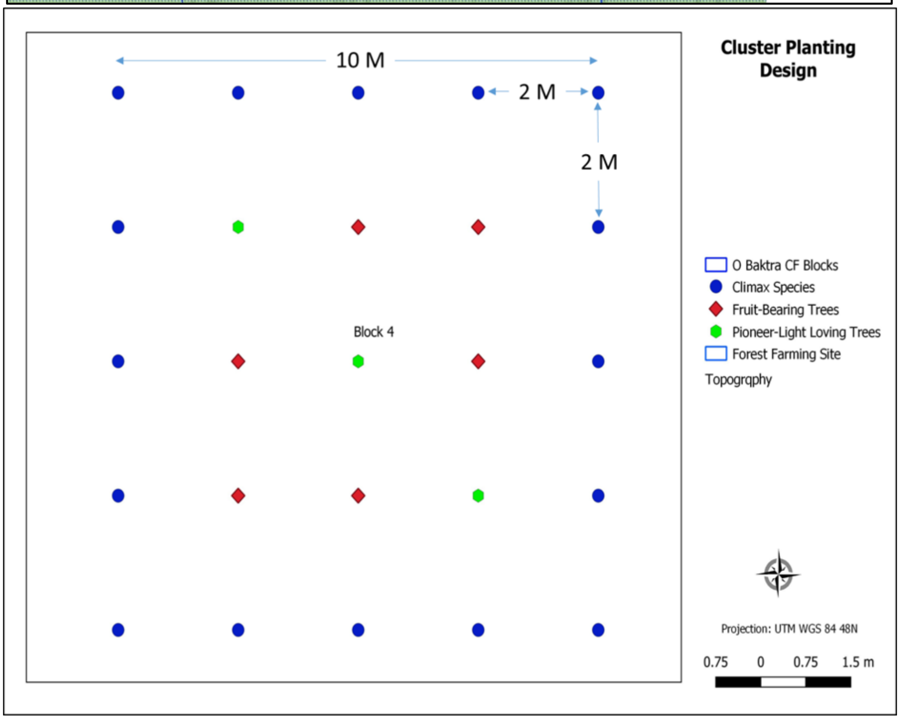


Figure 10 - Sketch of Model 7: Relative position of the cluster planting plots and Forest Farming area (top) and close up of the cluster planting plot detailing the species planted in each cluster plot (bottom)

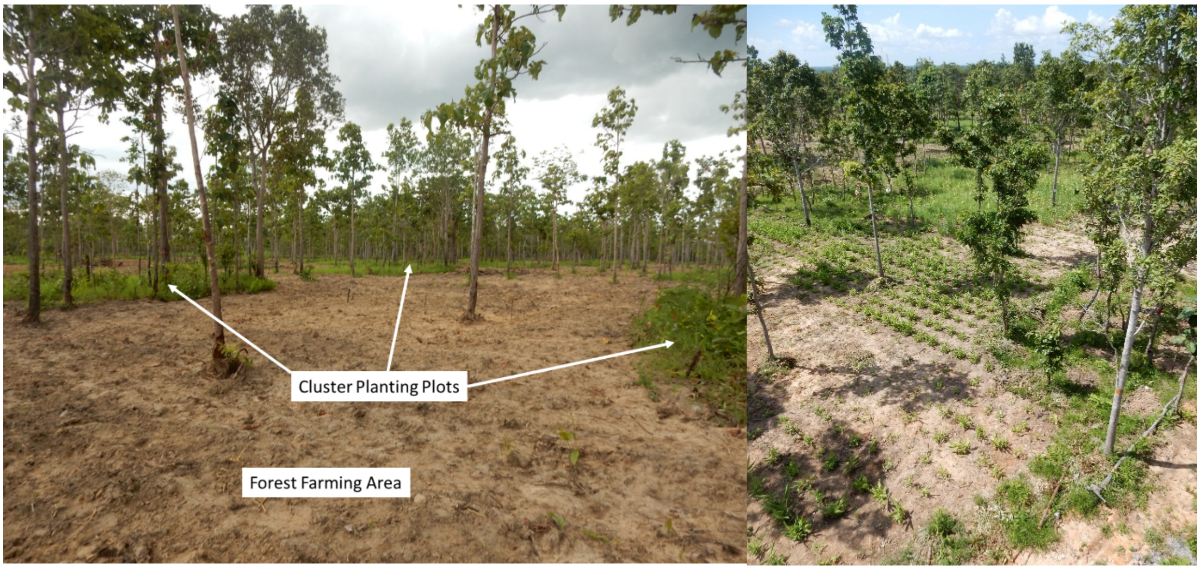


Figure 11 - Site preparation conducted in the Caritas Switzerland demonstration site in OU Baktra CF

Figure 12 - Turmeric and ginger planted in the forest farming plot in Ou Baktra CF

Figure 13 - Plants planted in the cluster plot. Top left is a picture shows the close up of a fruit tree Syzygium spp. and Luxury tree Pterocarpus macrocarpus planted in the cluster plot in Ou Baktra CF

The estimated costs for the cluster planting component only consider the development costs (i.e. covering the cost of seedlings and planting, and does not consider harvesting), since the trees planted are intended for conservation and restoration.

Forest farming involves the cultivation and management of understory crops within an established or developing forest.[7] Unlike other agroforestry practices, such as alley cropping, where trees are introduced into an agricultural system, forest farming intentionally integrates agricultural techniques into existing or newly established forests to farm Non Timber Forest Products (NTFPs).[8] Forest farming may take place in a natural forest setting or in a more organized plantation and can be a sustainable production system. The canopy of the forest is modified and maintained to provide the correct micro-conditions and protection for quality production of the understory or non-timber forest crops.[9]

Three crops (ginger, turmeric and lemon grass) (Table 12) were recently planted by farmer cooperators in Ou Baktra CF.[10] The selection of species was influenced by the existence of buyers especially turmeric and ginger. These crops also have well-established local and national markets as they are used for cooking and are traded in volume.

The costs and assumptions used in the financial analysis are expressed in the financial indicators. The assumptions were mostly based from interviews in Ou Baktra although some information was not available during the interview, such as the cost of hole digging using a mechanical hole digger. In such cases, information from other provinces was used as proxy costs.

The hole digging activities using a mechanical hole digger will be done only during the first 2 years. It is assumed that thereafter, the soil will be friable and can easily be planted with turmeric. Mulching, one of the important features of Conservation Agriculture, will also control weeds, making weeding and brushing unnecessary. Finally, the costs of this model included technical assistance.

---

[7] https://articles.extension.org/pages/64919/forest-farming-and-non-timber-forest-products-defined
[8] http://www.centerforagroforestry.org/academy/2015/chp7-ForestFarming_2015.pdf
[9] https://articles.extension.org/pages/64919/forest-farming-and-non-timber-forest-products-defined
[10] The technical description of the three species is shown in Annex 3.

Table 17 - Cash flow of Model 1 – Cambodia - Turmeric, ginger and lemon grass as forest farming crops

Year	Gross Revenue (US$)	Tax on Sales (US$)	Cost & Investments (US$)	Cash Flow before income tax (US$)	Tax on Income (US$)	Cash Flow after taxes (US$)
1	3,663.00	-	7,736.00	-4,073.00	-	-4,073.00
2	3,663.00	-	7,476.00	-3,813.00	-	-3,813.00
3	3,663.00	-	3,190.00	473	-	473
4	3,663.00	-	2,655.00	1,008.00	-	1,008.00
5	3,663.00	-	2,655.00	1,008.00	-	1,008.00
6	3,663.00	-	2,655.00	1,008.00	-	1,008.00
7	3,663.00	-	2,655.00	1,008.00	-	1,008.00
8	3,663.00	-	2,655.00	1,008.00	-	1,008.00
9	3,663.00	-	2,655.00	1,008.00	-	1,008.00
10	3,663.00	-	2,655.00	1,008.00	-	1,008.00
11	3,663.00	-	2,655.00	1,008.00	-	1,008.00
12	3,663.00	-	2,655.00	1,008.00	-	1,008.00
13	3,663.00	-	2,655.00	1,008.00	-	1,008.00
14	3,663.00	-	2,655.00	1,008.00	-	1,008.00
15	3,663.00	-	2,655.00	1,008.00	-	1,008.00
16	3,663.00	-	2,655.00	1,008.00	-	1,008.00
17	3,663.00	-	2,655.00	1,008.00	-	1,008.00
18	3,663.00	-	2,655.00	1,008.00	-	1,008.00
19	3,663.00	-	2,655.00	1,008.00	-	1,008.00
20	3,663.00	-	2,655.00	1,008.00	-	1,008.00
21	3,663.00	-	2,655.00	1,008.00	-	1,008.00
22	3,663.00	-	2,655.00	1,008.00	-	1,008.00
23	3,663.00	-	2,655.00	1,008.00	-	1,008.00
24	3,663.00	-	2,655.00	1,008.00	-	1,008.00
25	3,663.00	-	2,655.00	1,008.00	-	1,008.00
26	3,663.00	-	2,655.00	1,008.00	-	1,008.00
27	3,663.00	-	2,655.00	1,008.00	-	1,008.00
28	3,663.00	-	2,655.00	1,008.00	-	1,008.00
29	3,663.00	-	2,655.00	1,008.00	-	1,008.00
30	3,663.00	-	2,655.00	1,008.00	-	1,008.00
TOTAL	34,530.80		81,897.30			

Table 18 - Assumptions and basis in developing the cash flow (Model 7 - Cambodia) analysis for forest farming using turmeric, ginger and lemon grass*

Outputs / Key Activities	Total Cost per Ha. over a period of 30 years	Computation**
1.0 Initial Investments	**69,215**	
1.1 Fencing	**0**	No need to fence
1.2 Forest Farming	**68,831**	
1.2.1 Brushing and Pruning of Saplings and Mulching the Site	**2,400**	
Labor Cost (Package)	**2,400**	@ 30 Ha. x 80 $/Ha.
1.2.2 Hole Digging	**8,433**	
Labor Cost (Package)	**4,167**	@ 556 person-day x 7.5 $/Person-day
Gasoline for Hole Digging	**4,167**	@ 3333 li. x 1.25 $/li.
Rental for Hole Digging Eqt.	**100**	@ 2 days x 50 $/day
1.2.3 Seedling Transport and Planting	**57,998**	
Labor Cost (Package)	**900**	@ 1 Ha./Yr.; 30 Has. x 30 $/Ha.
Cost of Planting Materials: Turmeric	**18,750**	@ 9,375 kgs. x 2 $/kg.
Cost of Planting Materials: Lemon Grass	**848**	@ 1,785 kgs. x 0.475 $/kg.
Cost of Planting Materials: Ginger	**37,500**	@ 18,750 kgs. x 2 $/kg.
Fertilizers	**0**	Will not apply fertilizers
1.3 Cluster Planting	**384**	
1.3.1 Brushing and Pruning of Saplings and Mulching the Site	**80**	
Labor Cost (Package)	**80**	@ 1 Ha. x 80 $/Ha.
1.3.2 Hole Digging	**26**	
Labor Cost	**26**	@ 3.4375 person-day x 7.5 $/Person-day
1.3.3 Seedling Transport and Planting	**278**	
Labor Cost (Package)	**3**	@ 0.11 Has. x 30 $/Ha.
Cost of Seedlings	**275**	@ 275 seedlings x 1 $/seedling
2.0 Maintenance and Technical Assistance	**11,762**	
2.1 Forest Farming	**2,378**	
2.1.1 Maintenance Weeding Using Grass Cutter	**1,440**	
Labor Cost (Package)	**1,440**	@ 18 kgs. x 80 $/Ha./Weeding Pass
2.1.2 Fertilizer Application	**938**	
Cost of Cow Dung	**938**	@ 37500 kgs. x 2.5 $/100 kgs.
Labor Cost (Package)	**0**	None
2.2 Cluster Planting	**984**	
2.2.1 Maintenance Weeding	**106**	

Outputs / Key Activities	Total Cost per Ha. over a period of 30 years	Computation**
Labor Cost	**106**	@ 0.22 Ha. x 80 $/Ha. x 6 Brushings/Yr.
2.2.2 Replanting (Yr. 2 and 3)	**87**	
Labor Cost	**4**	@ 2 replantings x 2 $/replanting
Seedling Cost	**82**	@ 82 seedlings (for 2 years) x 1 $/seedling
2.2.3 Fireline and Firebreak Construction and Maintenance Around the Periphery of Plot	**792**	
Labor Cost	**792**	@ 79, 200 sq.m. x 100 $/10000 sq.m.
2.3 Technical Assistance	**8,400**	
Technical Assistance Cost	**8,000**	@ 320 person-day x 25 $/person-day/Ha.
Gasoline	**400**	@ 320 li. x 1.25 $/li./Ha.
3.0 Harvesting Cost (for Forest Farming)	**9,141**	
3.1 Harvesting and Processing	**900**	
Labor Cost	**900**	@ 30 Ha. x 30 $/Ha.
3.2 Transport of Harvested Products	**8,241**	
Transport Cost (7.5% of Value of Products)	**8,241**	
TOTAL EXPENSES	**90,118**	

*Turmeric = 0.25 Ha.; Lemon Grass = 0.25 Ha.; Ginger = 0.5 Ha.

**Annual development = 1 Ha. Over 30 year period, some costs, like planting, will be equivalent to 30 has. (i.e. 1 Ha./Year x 30 years)

Table 19 - Financial indicators of Model 1 – Cambodia - Turmeric, ginger and lemon grass as forest farming crops

Item	Value (USD)
Area (hectares)	1.0
Investment	7,786
Investment/ha	7,786
IRR	10.78%
NPV	536
NPV/ha	536
Benefit/Cost Ratio	1.01

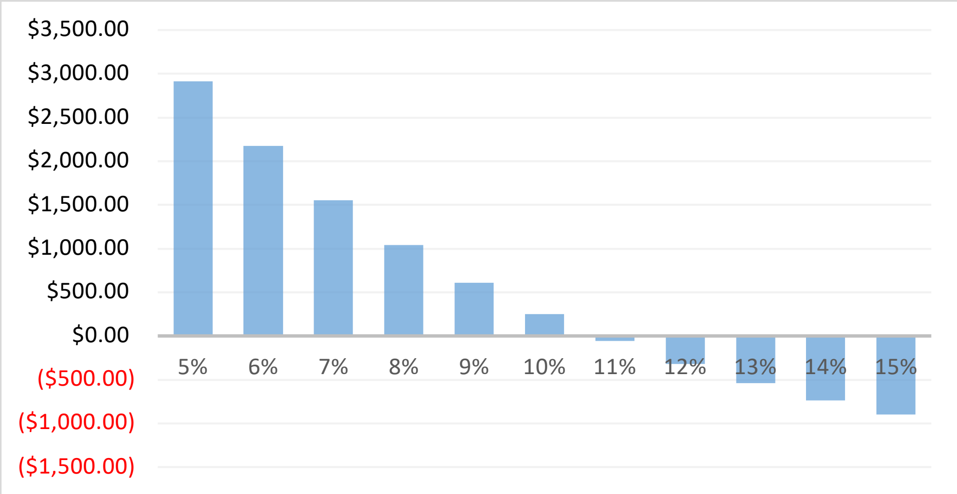


Figure 14 - Sensitivity Analysis – NPV/ha x Discount Rate – Model 1 (Cambodia: Turmeric, ginger and lemon grass as forest farming crops)

Model 2 - Rattan and Bamboo as Forest Farming Crops

This model represents a variation of forest farming, shown in Model 7, and considers the use of rattan and bamboo instead of turmeric, ginger and lemon grass, maintaining the concept of using forest clusters between the crops. The potential rattan and bamboo species that will be used for planting are listed in Annex 2. Although the design is similar, rattan and bamboo will be planted at 5m x 5m. The data for the planting, maintenance, harvesting and yield were based on the information collected from Sre Ambel District in Koh Kong province.

It is noted that the price of rattan and bamboo are very low. Also, the bamboo and rattan species considered are small in size, used mainly as garden trellises or other lesser value products.

The costs of this model included technical assistance. Unlike in forest farming using ginger, turmeric and lemon grass, the process of planting these crops is done only once. Harvesting starts after 6 years for rattan and after 5 years for bamboo. The cash flow analysis showed that using the cost estimate and prevailing yield and prices of rattan and bamboo cannot offset the expenses incurred in developing the forest farm.

Table 20 - Cash flow of Model 2 – Cambodia - Rattan and Bamboo as Forest Farming Crops

Year	Gross Revenue (US$)	Tax on Sales (US$)	Cost & Investments (US$)	Cash Flow before income tax (US$)	Tax on Income (US$)	Cash Flow after taxes (US$)
1	-	-	1,548.00	-1,548.00	-	-1,548.00
2	-	-	990	-990	-	-990
3	-	-	871	-871	-	-871
4	-	-	816	-816	-	-816
5	-	-	336	-336	-	-336
6	568	-	379	189	-	189

Year	Gross Revenue (US$)	Tax on Sales (US$)	Cost & Investments (US$)	Cash Flow before income tax (US$)	Tax on Income (US$)	Cash Flow after taxes (US$)
7	770	-	394	376	-	376
8	777	-	394	383	-	383
9	785	-	395	390	-	390
10	793	-	395	398	-	398
11	800	-	396	404	-	404
12	808	-	397	411	-	411
13	816	-	397	419	-	419
14	823	-	398	425	-	425
15	831	-	398	433	-	433
16	838	-	399	439	-	439
17	846	-	399	447	-	447
18	854	-	400	454	-	454
19	861	-	401	460	-	460
20	869	-	401	468	-	468
21	877	-	402	475	-	475
22	884	-	402	482	-	482
23	892	-	403	489	-	489
24	900	-	403	497	-	497
25	907	-	404	503	-	503
26	915	-	405	510	-	510
27	922	-	405	517	-	517
28	930	-	406	524	-	524
29	938	-	407	531	-	531
30	945	-	407	538	-	538
TOTAL	4,506.70		13,225.50			

Table 21 - Assumptions and basis in developing the cash flow (Model 2) analysis for forest farming using rattan and bamboo in Ou Baktra CF*

Outputs / Key Activities	**Total Cost per Ha. over a period of 30 years**	Computation**
1.0 Initial Investments	**1,262**	
1.1 Fencing	**-**	No fencing is needed
1.2 Forest Farming	**878**	
1.2.1 Brushing and Pruning of Saplings and Mulching the Site	**80**	

Outputs / Key Activities	Total Cost per Ha. over a period of 30 years	Computation**
Labor Cost (Package)	**80**	@ 1 Ha. x 80 $/Ha.
1.2.2 Hole Digging	**168**	
Labor Cost (Package)	**38**	@ 5 person-day x 7.5 $/Person-day
Gasoline for Hole Digging	**30**	@ 24 li. x 1.25 $/li.
Rental for Hole Digging Eqt.	**100**	@ 2 days x 50 $/day
1.2.3 Seedling Transport and Planting	**630**	
Labor Cost (Package)	**30**	@ 1 Has. x 30 $/Ha.
Cost of Planting Materials: Rattan	**200**	@ 200 sdlngs x 1 $/seedling
Cost of Planting Materials: Bamboo	**400**	@ 200 sdlngs x 2 $/seedling
Fertilizers	**-**	Will not apply
1.3 Cluster Planting	**384**	
1.3.1 Brushing and Pruning of Saplings and Mulching the Site	**80**	
Labor Cost (Package)	**80**	@ 1 Ha. x 80 $/Ha.
1.3.2 Hole Digging	**26**	
Labor Cost	**26**	@ 3.4 person-day x 7.5 $/Person-day
1.3.3 Seedling Transport and Planting	**278**	
Labor Cost (Package)	**3**	@ 0.11 Ha. x 30 $/Ha.
Cost of Seedlings	**275**	@ 275 seedlings x 1 $/seedling
2.0 Maintenance and Technical Assistance	**11,748**	
2.1 Forest Farming	**2,378**	
2.1.1 Maintenance Weeding Using Grass Cutter	**1,440**	
Labor Cost (Package)	**1,440**	@ 18 weeding x 80 $/Ha./Weeding Pass
2.1.2 Fertilizer Application	**938**	
Cost of Cow Dung	**938**	@ 37,500 kgs. x 2.5 $/100 kgs.
Labor Cost (Package)	**-**	None
2.2 Cluster Planting	**971**	
2.2.1 Maintenance Weeding	**106**	
Labor Cost	**106**	@ 0.22 Ha. x 80 $/Ha. x 6 Brushings/Yr.
2.2.2 Replanting (Yr. 2 and 3)	**73**	
Labor Cost	**4**	@ lump sum
Cost of Seedlings	**69**	@ 69 seedlings x 1 $/seedling

Outputs / Key Activities	Total Cost per Ha. over a period of 30 years	Computation**
2.2.3 Fireline and Firebreak Construction and Maintenance Around the Periphery of Plot	**792**	
Labor Cost	**792**	@ 79200 sq.m. x 100 $/10000 sq.m.
2.3 Technical Assistance	**8,400**	
Technical Assistance Cost	**8,000**	@ 320 person-day x 25 $/person-day/Ha.
Gasoline	**400**	@ 320 li. x 1.25 $/li./Ha.
3.0 Harvesting Cost (for Forest Farming)	**2,486**	
3.1 Harvesting and Processing	**900**	
Labor Cost	**900**	@ 30 Ha. x 30 $/Ha.
3.2 Transport of Harvested Products	**1,586**	
Transport Cost (7.5% of Value of Products)	**1,586**	
TOTAL EXPENSES	**15,496**	

*Rattan = 0.50 Ha.; Bamboo = 0.50 Ha.

*Annual development = 1 Ha. Over 30 year period, some costs, like planting, will be equivalent to 30 has. (i.e. 1 Ha./Year x 30 years)

Table 22 - Financial indicators of Model 2 – Cambodia - Rattan and Bamboo as Forest Farming Crops

Item	Value (USD)
Area (hectares)	1.0
Investment	1,548
Investment/ha	1,548
IRR	6.07%
NPV	(1,511)
NPV/ha	(1,511)
Benefit/Cost Ratio	0.72

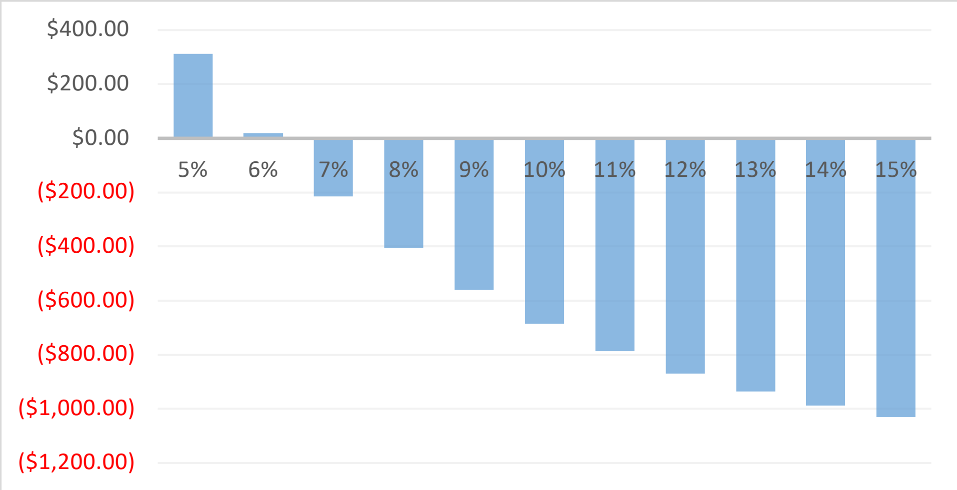


Figure 15 - Sensitivity Analysis – NPV/ha x Discount Rate – Model 2 – Cambodia - Rattan and Bamboo as Forest Farming Crops

Model 3 - Taungya Model

Several plantations are established by the government, NGOs and Economic Land Concessions in Cambodia. The latter are developing large tracts of land for rubber and industrial tree plantations. Some rubber plantations are intercropped during early stages of development. The planting of profitable crops between spaces has the potential to contribute to food security in the country.

The Taungya model was done in the seed orchard established by the Institute of Forest and Wildlife Research and Development (IRD) in Chansor Research Station. The spacing of the seed orchard is 5m x 5m, which is enough space between the planted timber for the crops. In this model, peanuts were planted between native trees. The primary purpose of planting the legume is to enrich the soil by intercropping leguminous species, and to control weeds, meeting the restoration purpose.

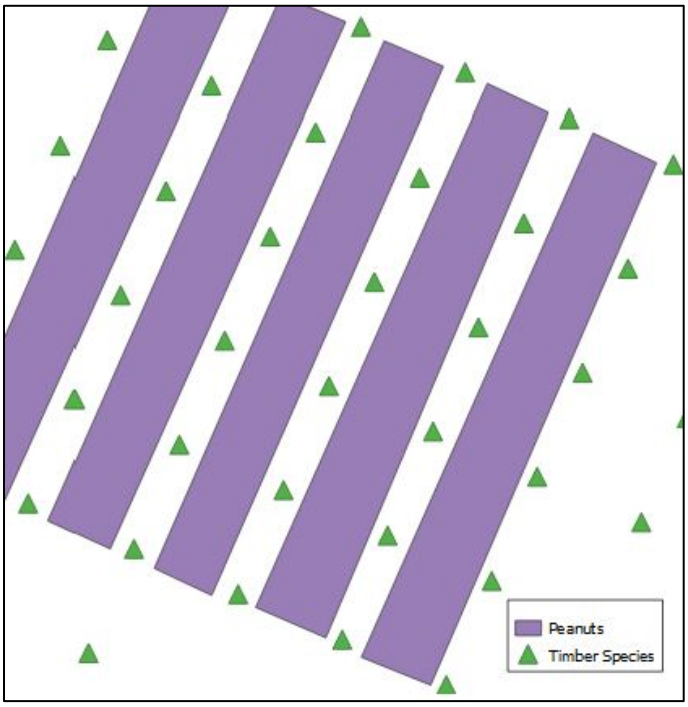


Figure 16 - Sketch of Model 3 (Taungya) located in the seed orchard of Institutre of Forest and Widlife Research and Development in Chansor Research Station in Siem Reap province

Figure 17 - Newly planted peanuts interplanted in a one-year-old grafted Dalbergia seedlings in a Seed Orchard in Chansor Research Station

In this analysis, the Taungya model will integrate Conservation Agriculture (i.e. no tillage). The period of peanut harvest, in this model, is 6 years. Due to the canopy closure the site will no longer be suitable for growing of peanuts after year 6, and will no longer provide income.[11] Considering this, the period of analysis of this model is 6 years.

Table 23 - Cash flow of Model 3 - Cambodia - Taungya

[11] When the canopy starts to close, other shade tolerant crops may be planted instead of peanuts and will resemble forest farming practices. This option is not included in the analysis, being beyond the scope of this work.

Year	Gross Revenue (US$)	Tax on Sales (US$)	Cost & Investments (US$)	Cash Flow before income tax (US$)	Tax on Income (US$)	Cash Flow after taxes (US$)
1	3,500	-	12,650	(9,150)	-	(9,150)
2	3,500	-	6,724	(3,224)	-	(3,224)
3	3,500	-	244	3,256	-	3,256
4	3,500	-	244	3,256	-	3,256
5	3,500	-	244	3,256	-	3,256
6	3,500	-	244	3,256	-	3,256
TOTAL	15,243		18,500			

Table 24 - Cost assumptions for Taungya Model (Model 3) Cambodia

Outputs / Key Activities	**Total Cost per Ha. over a period of 6 years**	Computation*
1.0 Initial Investments	**13,385**	
1.1 Fencing	**-**	
1.2 Brushing and Mulching the Site	**480**	
Labor Cost (Package)	**480**	@ 6 Ha. x 80 $/Ha.
1.3 Fireline and Firebreak Construction and Maintenance	**127**	
Labor Cost (Package)	**127**	@ 1.58 Ha. x 80 $/Ha.
1.4 Hole Digging	**12,100**	
Labor Cost (Package)	**6,000**	@ 800 person-day x 7.5 $/Person-day
Gasoline for Hole Digging	**6,000**	@ 4800 li. x 1.25 $/li.
Rental for Hole Digging Eqt.	**100**	@ 2 days x 50 $/day
1.5 Seedling Transport and Planting	**678**	
Labor Cost (Package)	**180**	@ 6 Has. x 30 $/Ha.
Cost of Planting Materials	**498**	@ 6 Ha. x 83 $/Ha.
Fertilizers	**-**	Will not apply
2.0 Maintenance and Technical Assistance	**13,951**	
2.1 Maintenance Weeding Using Grass Cutter	**960**	
Labor Cost (Package)	**960**	@ 12 weeding x 80 $/Ha./Weeding Pass
2.2 Fertilizer Application	**31**	
Cost of Cow Dung	**31**	@ 1250 kgs. x 2.5 $/100 kgs.

Outputs / Key Activities	Total Cost per Ha. over a period of 6 years	Computation*
Labor Cost (Package)	-	None
2.3 Technical Assistance	**12,960**	
Technical Assistance Cost	**7,200**	@ 288 person-day x 25 $/person-day/Ha.
Gasoline	**5,760**	@ 5760 li. x 1 $/li.
3.0 Harvesting Cost (for Forest Farming)	**180**	
3.1 Harvesting and Processing	**180**	
Labor Cost	**180**	@ 6 Ha. x 30 $/Ha.
3.2 Transport of Harvested Products	**-**	
Transport Cost	**-**	None, Sold on Farm
TOTAL EXPENSES	**27,516**	

*Annual development = 1 Ha. Over 6 year period, some costs, like planting, will be equivalent to 6 has. (i.e. 1 Ha./Year x 6 years)

Table 25 - Financial indicators of Model 3 - Cambodia - Taungya Model

Item	Value (USD)
Area (hectares)	6.0
Investment	8,965
Investment/ha	1,494
IRR	-
NPV	(7,247)
NPV/ha	(1,207)
Benefit/Cost Ratio	0.70

Overall results

In order to compare the results among the models, the overall results and perceptions of each restoration proposal are organized in Table 18. The models with the highest economic viability were observed in Peru. Even though they presented problems related to selling the products, the NPV of those models were higher than US$ 2,700 per hectare, with one model reaching up to US$ 30,000 per hectare, which indicates the country's potential for this kind of initiative. In contrast, the models in Cambodia presented the lowest financial indicators values due to larger investment values.

Furthermore, the seeds dispersion models presented a cost of USD 670 and USD 1,600 per hectare. These results indicate that restoration models using this technique have a relatively high initial investment. However, these models have the lowest costs over time, which compensates the implementation expenses.

The following tables presents a summary of results for models assessed, and also addresses some contextual/qualitative question.

Table 26 - Overall results and perceptions on Cambodia models

Case	1	2	3
Restoration model	Modified Caritas Model - Cluster Planting	Modified Caritas Model - Cluster Planting	Taungya Model
Species 1 (name)	Lemongrass	Bamboo	Peanuts
Species 2 (name)	Turmeric	Rattan	Timber Species
Species 3 (name)	Ginger		
Species 4 (name)			
Species 5 (name)			
Species 6 (name)			
% of native vegetation and productive species	100%	100%	100%
Property Total Area (ha)	1	1	6
Main productive Activity	Forest Farming	Forest Farming	Peanuts and Timber Species
Secondary Activity	Management of the Community Forest	Management of the Community Forest	Seed Orchard Management
Biophisical conditions (slope, soil)	Flat-Gently rolling; Clayey	Flat-Gently rolling; Clayey	Flat; Sandy to Sandyloam
Initial investment (US$)	$ 7,786	$ 1,548	$ 8,965
Investment / ha (US$/ha)	$ 7,786	$ 1,548	$ 1,494
NPV (US$)	$ 536	$ (1,511)	$ (7,247)
NPV / ha (US$)	$ 536	$ (1,511)	$ (1,207)
IRR	11%	6%	N/A

Technical Capacity on Restoration in the Region (low/high)	High	Low	High (permanent training of C.I technicians.
Logistics / Access to Markets	Limited	Limited	Limited
Legal obligation to restore? (yes/no)	No	No	No

Table 27 - Overall results and perceptions on Indonesia models

Case	1	2	3
Restoration model	Lowland Restoration	Highland Restoration	Seed dispersal
Species 1 (name)	Coconut (*Cocos nucifera)*	Meranti (*Shorea sp.*)	
Species 2 (name)	Ketapang (*Terminalia catappa*)	Durio (*Durio zibethinus*)	
Species 3 (name)	Cemara Laut (*Casuarina equisetifolia*)	Manguis (*Garcinia mangostana)*	
Species 4 (name)		Coconut (*Cocos nucifera)*	
Species 5 (name)			
Species 6 (name)			
% of native vegetation and productive species	50% and 50%	25% and 75%	100%
Property Total Area (ha)	2	2	1
Main productive Activity	Farmer and/or fisher	Farmer and/or fisher	Restoration
Secondary Activity	Labor to palm plantation	Labor to farm and off-farm	
Biophisical conditions (slope, soil)	Coastal area and peatland, mosty flat	Hilly and mountanious	
Initial investment (US$)	$ 208.30	$ 434,21	$ 1,600

Investment / ha (US$/ha)	$ 104.15	$ 217.11	$ 1,600
NPV (US$)	$ 449.01	$ 3,639	
NPV / ha (US$)	$ 224.50	$ 1,819	
IRR	0.222%	26.74%	
Technical Capacity on Restoration in the Region (low/high)	Low; need more skill and capacity building	Low; need more skill and capacity building	Low
Logistics / Access to Markets	Little, potential to be improved	Little, potential to be improved	
Legal obligation to restore? (yes/no)	Yes	Yes	Yes

Table 28 - Overall results and perceptions on Peru models.

Case	1	2	3
Restoration model	Agroforestry system	Agroforestry system	Seed dispersal
Species 1 (name)	Cocoa	Coffee	N/A
Species 2 (name)	Pino chuncho	Cocoa	N/A
Species 3 (name)	Bolaina	Guaba	N/A
Species 4 (name)	Capirona	Jacaranda	N/A
Species 5 (name)	Shaina		N/A
Species 6 (name)	Cedro de la india		N/A
% of native vegetation and productive species	86% Cocoa; 8% Pino chuncho; 2% Bolaina; 2% Capirona; 2% Shaina; 2% Cedro de la india	84% Coffee; 8% Guaba; 7% Cocoa; 1% Jacaranda	N/A
Property Total Area (ha)	5.8	3.00	1

Main productive Activity	Cocoa	Coffee	Restoration
Secondary Activity	Cattle	Cocoa	N/A
Biophisical conditions (slope, soil)	Clayey rock surface with 45° slope	Clayey and flat surface	Clayey and flat surface
Initial investment (US$)	$ 2.600	$ 620	$ 3,350
Investment / ha (US$/ha)	$ 452	$ 207	$ 3,350
NPV (US$)	$ 15.552,00	$ 7.482	N/A
NPV / ha (US$)	$ 2.705,00	$ 2.494,00	N/A
IRR	40%	88%	N/A
Technical Capacity on Restoration in the Region (low/high)	High (permanent training of C.I technicians.	High (permanent training of C.I technicians.	High
Logistics / Access to Markets	High demand on cocoa beans.	High demand on cocoa beans.	
Legal obligation to restore? (yes/no)	Yes (Conservation agreement)	Yes (Conservation agreement)	Yes

Final Remarks

The literature review identified almost no information about forest restoration costs in the profiled countries, corroborating other studies indicating the lack of economic information worldwide (Wortley et al. 2013)[12]. This gap in knowledge is being addressed here, in an effort to encourage the implementation of large-scale initiatives such as the Bonn Challenge and demand indicated by the IPCC (IPCC 2014)[13] to stabilize anthropogenic climate change.

Regarding restoration public policies, it was apparent there is a lack of legislation clearly determining what percentage of properties should be conserved or restored, meaning that forest restoration is mainly a voluntary initiative in the profiled countries. In the case of Indonesia, for example, the government has ambitious restoration targets, and is seeking to incentivize these initiatives. However, in other countries, establishing a legal framework for forest restoration is still a challenge.

---

[12] Wortley, L., Hero, J.M. & Howes, M. Evaluating Ecological Restoration Success: A Review of the Literature. Restoration Ecology. V21 n5 pp 537-543. 2013.

[13] Intergovernmental Panel on Climate Change – IPCC. Climate Change 2014: Impacts, Adaptation and Vulnerability. IPCC Working group II contribution to AR5. Available at https://www.ipcc.ch/report/ar5/wg2/. 2014.

This study found that the forest restoration initiatives are mostly conducted by non-governmental organizations and in some places, they have also support from the government. However, in both cases, restoration models are not chosen based on economic performance. Some of these initiatives might be implemented in protected areas, to generate income to local communities, while others refer to ecological improvements in private or communal farms. In general, farmers have little theoretical and practical experience in forest restoration. Thus, the models included technical assistance costs to ensure the engagement of farmers without technical knowledge and the proper replication of the proposed models.

The study identified average forest restoration total deployment costs per hectare and approximately to one year period, vary from around USD 515 in Peru, to USD 640 in Indonesia, and USD 3,642 in Cambodia – with an overall average of UDS 1,600. Five out of the 6 restoration models with economic goals (not considering the seeds dispersion models) yielded Internal Rates of Return larger than the discount rate, which means they are capable of paying back initial investments, inputs and labor costs with positive net economic returns. Regarding the selected models, Model 2 implemented in Peru, including coffee and cocoa as the main species, had the highest returns, which suggests a high potential for plant agroforestry systems in degraded areas with very low investment costs and a promising market for the selected species.

Bibliography from Peru Cases

Scientific Articles consulted:

Andersen et al. 2009. Social Impacts of Climate Change in Peru. Policy Research Working Paper 5091. The World Bank, Washington, DC. 34 p.

Lapeyre et al. 2004. Determinación de las reservas de carbono de la biomasa aérea, en diferentes sistemas de uso de la tierra en San Martín, Perú. Ecología Aplicada, 3(1,2): 35-44.

Concha et al. 2007. determinación de las reservas de carbono en la biomasa aérea de sistemas agroforestales de *Theobroma* cacao en el departamento de San Martín, Perú. Ecología Aplicada 6(1,2): 75-82.

Chuquizuta et al. 2016. Carbono almacenado en cinco sistemas de uso de tierra, en la región San Martín Perú. RINDERESU 1(2): 57-67.

Documents consulted from official sources on the internet:

- https://www.sunass.gob.pe/websunass/index.php/eps/sunass-comprometida-con-el-cuidado-de-las-fuentes-de-agua
- https://www.conservation.org/global/peru/iniciativas_actuales/Pages/Iniciativas_Actuales.aspx
- https://www.mef.gob.pe/es/aplicaciones-informaticas/71-inversion-publica/157-proyectos-de-inversion-publica-busqueda-avanzada
- https://www.serfor.gob.pe/wp-content/uploads/2018/11/GuiaRestauracion-A4-FINAL-OK.pdf
- https://www.serfor.gob.pe/wp-content/uploads/2019/01/Experiencias-de-Restauraci%C3%B3n-en-el-Per%C3%BA-Lecciones-aprendidas.pdf
- https://legislacionanp.org.pe/images/documentospdf/PlanesMaestros/BosquesProteccion/AltoMayo/Plan%20Maestro%202008%20-%202013%20BP%20Alto%20Mayo%20ver%20publ.pdf
- http://www.bosques.gob.pe/
- https://andina.pe/agencia/noticia-madre-dios-iniciativa-recuperara-140-hectareas-suelos-degradados-mineria-ilegal-693578.aspx

Bibliography from Indonesia Cases

Anonymous. 2018. Business Models for Restoration in the Context of Forest Landscape Restoration in South America –Terms of Reference. WWF Chile, 2018.

Ayat A. 2015. Restorasi ekosistem di hutan produksi: Memulihkan ekosistem hutan alam Indonesia. *Kiprah Agroforestri-ICRAF Indonesia*, 8(2):3-5.

Bahri AD, Kartodihardjo H, Ekawati S. 2019. The Practice of discretion in implementing forest-rehabilitation policy in Forest Management Unit. *Journal of Natural Resources and Environmental Management*, 9(1): 52-60.

Bahri AD. 2017. Praktik Diskresi di Sektor Kehutanan: Tinjauan Rehabilitasi Hutan di KPHL Rinjani Barat [*thesis master*]. Bogor (ID): Institut Pertanian Bogor.

Barr C, Dermawan A, Purnomo H, Komarudin H. 2010. Financial Governance and Indonesia's Reforestation Fun During the Soeharto and Post-Soeharto Periods, 1989-2009: A Political Economic Analysis of Lessons for REDD+. Bogor (ID): CIFOR, Bogor.

Barr,C, Sayer MJA. 2012. The political economy of reforestation and forest restoration in Asia–Pacific: Critical issues for REDD+. Biological Conservation, 154:9–19.

BPS [Central Bureau of Statistics]. 2015. *Analisis Rumah Tangga Usaha Bidang Kehutanan dan Rumah Tangga Sekitar Hutan*. Jakarta (ID): BPS.

BPS [Central Bureau of Statistics]. 2018. Kabupaten Tapanuli Selatan Dalam Angka 2018. Padangsidimpuan (ID): BPS.

BPS Sumatera Utara [Central Bureau of Statistics]. 2014. *Angka Provinsi Sumatera Utara Hasil Survei ST2013 Rumah Tangga di Sekitar Kawasan Hutan, 2014*. Medan (ID): BPS.

CI [Conservation Indonesia]. 2014. Sustainable Investment Action Plan (SIAP) for South Tapanuli, June 2014. Jakarta (ID): CI Indonesia, Jakarta.

CI [Conservation International Indonesia]. 2019. North Sumatera Conservation Program [*presentation material*]. Jakarta (ID): CI Indonesia Jakarta.

Defidelwina. 2013. Financial feasibility assessment of people's oil palm plantation in Rokan Hulu District. *Agro Ekonomi*, 24(1):99-110.

Dephut [Ministry of Forestry/MoF]. 2008. *Statistik Kehutanan Indonesia 2008*. Jakarta (ID): Departemen Kehutanan.

FAO and UNCCD, 2017. Sustainable financing for forest and landscape restoration. The Role Of Public Policy Makers. UNCCD – The Global Mechanism.

Firdaus, N., A. Sudomo, E. Suhaendah, T.S. Widyaningsih, Sanudin, dan D.P. Kuswantoro. 2013. Status Riset Agroforestri di Indonesia. Balai Penelitian Teknologi Agroforestry. Ciamis.

FWI [Forest Watch Indonesia]. 2011. *Potret Keadaan Hutan Indonesia: Periode Tahun 2000-2009*. Bogor (ID): FWI.

FWI [Forest Watch Indonesia]. 2014. *Potret Keadaan Hutan Indonesia: Periode Tahun 2009-2013*. Bogor (ID): FWI.

Hobbs RJ, Norton DA. 1996. Towards a conceptual framework for restoration ecology. *Restoration Ecology*, 4(93).

Hutabarat S. 2011. Evaluasi Investasi Perkebunan Kelapa Sawit Pola PIR di Desa Gading Sari Kecamatan Tapung, Kabupaten Kampar. *Sorot, Jurnal Ilmu-ilmu Sosial*, 6(1):15-24.

Kartodihardjo H, Hendrayanto, Cahyono E, Bahri AD. 2014. Kesiapan daerah dalam pencegahan korupsi pada program penurunan emisi. Laporan Penelitian. Jakarta (ID): Tranparency International Indonesia.

Kartodihardjo H. 2006. Masalah kelembagaan dan arah kebijakan rehabilitasi hutan dan lahan. Jurnal Analisis Kebijakan Kehutanan, 3(1):29–41.

Kemenhut [Ministry of Forestry/MoF]. 2012. *Data dan Informasi Kesatuan Pengelolaan Hutan (KPH) Tahun 2012*. Jakarta (ID): Direktorat Jenderal Planologi Kehutanan, Kementerian Kehutanan.

KLHK [Ministry of Environtmen and Forestry/MoEF]. 2018. *Status Hutan dan Kehutanan Indonesia 2018*. Jakarta (ID): Kementerian Lingkungan Hidup dan Kehutanan.

KLHK [Ministry of Forestry/MoF]. 2016. *Statistik Kementerian Lingkungan Hidup dan Kehutanan Tahun 2015*. Jakarta (ID): Kementerian Lingkungan Hidup dan Kehutanan.

Margono BA, Turubanova S, Zhuravleva I, Potapov P, Tyukavina A, Baccini A, Goetz S, Hansen MC. 2012. Mapping and monitoring deforestation and forest degradation in Sumatra (Indonesia) using Landsat time series data sets from 1990 to 2010. *Environmental Research Letters*, 7(3):1-16.DOI:10.1088/1748-9326/7/3/034010.

Sabogal C., C. Besacier and D. McGuire. 2015. Forest and landscape restoration: concepts, approaches and challenges for implementation. Unasylva: Vol 66 – 2015/3. FAO

Sarasvati G. 2018. Analisis Kelayakan Investasi Pembangunan Perkebunan Kelapa Sawit PT XYZ di Kabupaten Morowali, Provinsi Sulawesi Tengah [undergraduate thesis]. Bogor: Bogor Agricultural University.

Stanturf JA. 2004. What is forest restoration? *in* Stanturf JA and Madsen P. *Restoration of Boreal and Temperate Forest*. London (UK): CRC Press.

Stanturf, John; Mansourian, Stephanie; Kleine, Michael; eds. 2017. Implementing Forest Landscape Restoration, A Practitioner‘s Guide. International Union of Forest Research Organizations, Special Programme for Development of Capacities (IUFRO-SPDC). Vienna, Austria. 128 p.

Svatoňova Tereza, Herak David, Kabutey Abraham. 2015. Financial Profi tability and Sensitivity Analysis of Palm Oil Plantation in Indonesia. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 63(4): 1365–1373.

Van Diggelen R, Grootjans AP, Harris JA. 2001. Ecological restoration: State of the art or state of the science? *Restoration Ecology*, 9(115).

Bibliography from Cambodia Cases

BPF. 2012. *Applying assisted natural regeneration (ANR) for restoring forest ecosystem services in Southeast Asia.* Inception Report for Cambodia. PROJECT TCP/RAS/3307. Phnom Penh, Cambodia. June, 2012.

Betts, H. 2013. The Framework Species Approach to forest restoration: using functional traits as predictors of species performance. Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy. July 2013. https://livrepository.liverpool.ac.uk/15393/4/BettsHannah_July2013_15393.pdf

Carle, Jim (1998). Reforestation and natural forest rehabilitation policy in Cambodia. In: _In: Gilmour, D.A.; Van San, N.; and Tsechalicha, X. 2000. Rehabilitation of degraded forest ecosystems in Cambodia, Lao PDR, Thailand and Vietnam. Conservation Issues in Asia. WWF, GTZ and IUCN. http://www.mekonginfo.org/assets/midocs/0001716-environment-rehabilitation-of-degraded-forest-ecosystems-in-cambodia-lao-pdr-thailand-and-vietnam.pdf (Date accessed: July 12, 2019).

Derpsch, R., 2008. No-tillage and Conservation Agriculture: A Progress Report. In: Goddard, T., Zoebisch, M.A., Gan, Y.T., Ellis, W., Watson, A. and Sombatpanit, S. (eds) 2008. No-Till Farming Systems. Special Publication № 3, World Association of Soil and Water Conservation, Bangkok, ISBN:978-974-8391-60-1, p 7 – 39

Edralin, D.A.; Sigua, G.C.; Reyes, M.R.; Mulvaney, M.J.; and Andrews, S.S. 2017. Conservation agriculture improves yield and reduces weeding activity in sandy soils of CambodiaAgron. Sustain. Dev. 37: 52 DOI 10.1007/s13593-017-0461-7. https://link.springer.com/article/10.1007/s13593-017-0461-7

Ella, V.B.; Padre, R.; Reyes, M.R.; Mercado, A. Jr. 2014. Conservation agriculture and tillage effects on soil organic matter and residual moisture content in selected upland crop production systems in the Philippines. Proceedings International Conference of Agricultural Engineering, Zurich, 06-10.07.2014 – www.eurageng.eu

Elliott, S., Navakitbumrung, P., Kuarak, C., Zangkum, S., Anusarnsunthorn, V. and Blakesley, D. 2003. Selecting framework tree species for restoring seasonally dry tropical forests in northern Thailand based on field performance. *Forest Ecology and Management,* 184, 177-191.

Elliott, S., Navakitbumrung, P., Kuarak, C., Zangkum, S., Anusarnsunthorn, V., Blakesley, D., 2003. Selecting framework tree species for restoring seasonally dry tropical forests in northern Thailand based on field performance. In: Stanturf, J.A.; Palik, B.J.; Dumroese, R.K. 2014. Contemporary forest restoration: A review emphasizing function. Forest Ecology and Management 331 (2014) 292–323.

Elliott, S., Kuaraksa, C., Tunjai, P., Toktang, T., Boonsai, K., Sangkum, S., Suwannaratana, S., Blakesley, D., 2012. Integrating scientific research with community needs to restore a forest landscape in northern Thailand: a case study of Ban Mae Sa Mai. In: Stanturf, J., Madsen, P., Lamb, D. (Eds.), A Goal-Oriented Approach to Forest Landscape Restoration. Springer, Dordrecht, pp. 149–161.

FA and FAO. 2010. Cambodia Forestry Outlook Study. Asia-Pacific Forestry Sector Outlook Study II. Working Paper Series. Working Paper No. APFSOS II/WP/2010/32. Phnom Penh: Forestry Administration (FA) and Food and Agriculture Organization of the United Nations, Regional Office for Asia and the Pacific (FAO). http://www.fao.org/docrep/014/am627e/am627e00.pdf)

Gilmour, D.A.; Van San, N.; and Tsechalicha, X. 2000. Rehabilitation of degraded forest ecosystems in Cambodia, Lao PDR, Thailand and Vietnam. Conservation Issues in Asia. WWF, GTZ and IUCN. http://www.mekonginfo.org/assets/midocs/0001716-environment-rehabilitation-of-degraded-forest-ecosystems-in-cambodia-lao-pdr-thailand-and-vietnam.pdf (Date accessed: July 12, 2019).

Hillbrand, A.; Borelli, S.; Conigliaro, M.; Olivier, A. 2017. Exploring the potential of agroforestry to enhance the sustainability and resilience of degraded landscapes. Food and Agriculture Organization of the United Nations. Rome, 2017

ICEM. 2014. USAID Mekong ARCC Climate Change Impact and Adaptation Study on Protected Areas. Prepared for the United States Agency for International Development by ICEM – International Centre for Environmental Management.

International Center. Undated. New Forests Project and Agroforestry. The International Center. Washington, D.C. http://www.newforestsproject.org/agroforestry.html. (Date Accessed: May 15, 2019)

Lamb. D. 2014a. Post-establishment enrichment of restoration plots with timber and non-timber species. In: Bozzano, M., Jalonen, R., Thomas, E., Boshier, D., Gallo, L., Cavers, S., Bordács, S., Smith, P. & Loo, J., eds. 2014. *Genetic considerations in ecosystem restoration using native tree species*. State of the World's Forest Genetic Resources – Thematic Study. Rome, FAO and Bioversity International.

Lamb, D. and Gilmour, D. 2003. Rehabilitation and Restoration of Degraded Forests. IUCN, Gland, Switzerland and Cambridge, UK and WWF, Gland, Switzerland. x +110 pp.

Li, J., Merten, J., Burke, G., Mumford, E.C. (eds.) (2018). *Application of Restoration Opportunities Assessment Methodology (ROAM) in Asia. Summary of findings from the first Asia regional ROAM learning exchange*. Bangkok, Thailand: IUCN Asia Regional Office (ARO). vi+44pp.

Maningo, E.V. 2014. Technical Notes on Forest Restoration in Community Forests. Institute of Forest and Wildlife Research and Development. Phnom Penh (unpublished consultancy report).

Maningo, E.V. 2019. Enrichment Planting and Agroforestry Design of Ou Baktra CF. Phnom Penh: Unpublished Consultancy Report

Maningo, E.V. and Yim, K. 2017. Enhancing Climate Change Resilience of Rural Communities Living in Protected Areas in Cambodia: Unpublished Mid-Term Review Report.

Milan, P.P. Undated. Rainforestation: An Innovative Strategy in Forest Restoration.

Milan, P.P. 2014. “Rainforestation”: a paradigm shift in forest restoration. In: Bozzano, M., Jalonen, R., Thomas, E., Boshier, D., Gallo, L., Cavers, S., Bordács, S., Smith, P. & Loo, J., eds. 2014. Genetic considerations in ecosystem restoration using native tree species. State of the World’s Forest Genetic Resources – Thematic Study. Rome, FAO and Bioversity International.

Miyawaki, A. 2014. Miyawaki method. In: Bozzano, M., Jalonen, R., Thomas, E., Boshier, D., Gallo, L., Cavers, S., Bordács, S., Smith, P. & Loo, J., eds. 2014. *Genetic considerations in ecosystem restoration using native tree species*. State of the World’s Forest Genetic Resources – Thematic Study. Rome, FAO and Bioversity International.

Mulcahy, G. and Boissière, M. 2014. No forest, no NTFPs for rural communities in Cambodia. InfoBrief No. 67, February 2014. CIFOR and CIRAD.

Phimmavong, S.; Maraseni, T.N.; Keenan, R.J.; Cockfield, G. Financial returns from collaborative investment models of *Eucalyptus* agroforestry plantations in Lao PDR. Land Use Policy. Volume 87, September 2019. https://www.sciencedirect.com/science/article/abs/pii/S0264837718319872

Pornchai, P. Undated. Indigenous highland agroforestry systems of Northern Thailand. Chiang Doa Watershed Research Station. Chiang Mai, Thailand. http://www.mekonginfo.org/assets/midocs/0002240-farming-indigenous-highland-agroforestry-systems-of-northern-thailand.pdf (Date Accessed: July 7, 2019)

Prill, L. 2016. Planting trees to provide local wood resources and restore degraded dry tropical forests — Principles, challenges and research needs. Hamburg, Germany: Institute for World Forestry, University of Hamburg. February 2016

Rao, M.R.; Palada, M.C.; and Becker, B.N.. 2004. Medicinal and aromatic plants in agroforestry systems. Agroforestry Systems 61-62(1):107-122 · July 2004

Reyes, M.; Leng, V.; Tivet, F.; Hok, L.; Chan, S.; Boulakia, S.; Kong, R.; Sar, V.; Séguy, L.; Srean, P.; Lytour, L.; Rendal, T.; Hansen, A. 2018. Sustainable Agriculture in Cambodia: Current knowledge, application and future needs. Feed the Future. Cambodia Center of Conservation Agriculture in Southeast Asia. Siem Reap, Cambodia, August 27-29, 2018.

RGC. 2010. National Forest Programme 2010-2029. Phnom Penh: Royal Government of Cambodia.

Song Saa Foundation. Undated. Closing the Canopy’ A Tropical Rainforest Restoration Strategy. Song Saa Reserve, Eco-tourism Park, Banteay Srei. The Song Saa Foundation. https://songsaareserve.com/files_media/RFR_revised_Sept_2018-compressed.pdf. Date Accessed: June 27, 2019)

Stanturf, J.A.; Palik, B.J.; Dumroese, R.K. 2014. Contemporary forest restoration: A review emphasizing function. Forest Ecology and Management 331 (2014) 292–323.

Swift, Peter (ed.) (1998). Recommendations for the development of a community programme in Preah Sihanouk (Ream) National Park. In: Gilmour, D.A.; Van San, N.; and Tsechalicha, X. 2000. Rehabilitation of degraded forest ecosystems in Cambodia, Lao PDR, Thailand and Vietnam. Conservation Issues in Asia. WWF, GTZ and IUCN.

http://www.mekonginfo.org/assets/midocs/0001716-environment-rehabilitation-of-degraded-forest-ecosystems-in-cambodia-lao-pdr-thailand-and-vietnam.pdf (Date accessed: July 12, 2019).

Thomas, E. 2014. Assisted natural regeneration. In: Bozzano, M., Jalonen, R., Thomas, E., Boshier, D., Gallo, L., Cavers, S., Bordács, S., Smith, P. & Loo, J., eds. 2014. *Genetic considerations in ecosystem restoration using native tree species*. State of the World's Forest Genetic Resources – Thematic Study. Rome, FAO and Bioversity International.

Wagner, M.R., Block, W.M., Geils, B.W., Wenger, K.F., 2000. Restoration ecology: a new forest management paradigm, or another merit badge for foresters? In: Stanturf, J.A.; Palik, B.J.; Dumroese, R.K. 2014. Contemporary forest restoration: A review emphasizing function. Forest Ecology and Management 331 (2014) 292–323.

Wangpakapattanawong, P. and Stephen Elliott, S. 2008. Testing the Framework Species Method for Forest Restoration in Chiang Mai, Northern Thailand. *Walailak J Sci & Tech 2008; 5(1): 1-15.*