Report on Cost-Benefit Analysis of Forest Restoration Interventions in Sagaing Region, Myanmar

Bo Sann, Jake Brunner and Luke Brander

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Cover photo: A four-year old *Sterculia versicolor* plantation established as a community forest in Kyunhla Township © IUCN

Back Cover: A two-year-old pineapple orchard established as subsistence agriculture in Inndaw Township © IUCN

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Table of Contents

Acknowledgements ***vii***

1 Summary ***8***

2 Introduction ***8***

3 Methodology ***9***

3.1 Limitations and assumptions 10

4. Cost-benefit analysis of restoration interventions ***11***

4.1 Restoration through pure teak plantation 11
4.2 Restoration through community forestry (mango orchard) 12
4.3 Restoration through community forestry (*Sterculia versicolor*) 14
4.4 Restoration through conventional agriculture (pineapple orchard) 15
4.5 Restoration through teak and sesame intervention 16
4.6 Restoration through teak and sugarcane intervention 18

5. Summary of NPV, BCR and IRR of restoration interventions ***20***

6. Conclusions ***22***

References ***23***

Figure 1: Comparisons of NPVs, IRRs, and BCRs of Six Restoration Interventions in Sagaing Region, Myanmar 21

Figure 2: Trends of Cumulative NPVs of Six Restoration Interventions across the 30 year time frame in Sagaing Region, Myanmar 21

List of Tables

Table 1: *Costs and Benefits of Teak Plantation over 30 years* 12

Table 2: *Costs and Benefits of Mango Orchard over 30 years* 13

Table 3: *Costs and Benefits of Sterculia versicolor Plantation over 30 years* 15

Table 4: *Costs and Benefits of Pineapple Orchard over 30 years* 16

Table 5: *Costs and Benefits of Teak and Sesame Intervention over 30 years* 18

Table 6: *Costs and Benefits of Teak and Sugarcane Intervention over 30 years* 19

Table 7: *Summary of discounted costs and benefits for the six restoration interventions over a 30 year period in Sagaing Region, Myanmar* 20

Table 8: *Sensitivity analysis conducted at different discount rates over a 30-year period. Change (%) in NPV is calculated based on the baseline NPV at discount rate of 10%.* 22

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1 Summary

Knowledge on costs and benefits of restoration interventions can provide an insight for better allocation of resources within a restoration program. This report presents financial analysis of six restoration interventions in six townships of Sagaing Region, Myanmar. The objectives are to evaluate if an intervention type is financially viable and to determine which intervention type is more feasible. Data on costs and benefits of restoration interventions were collected in 2019 using a spreadsheet in each of six township-level ROAM workshops through a group discussion and later validated in 2020 during interviews with farmers. The time frame is set at 30 years to make easy comparisons among the interventions. Future costs and benefits are estimated using an annual discount rate of 10% based on current year values. This analysis calculates three financial indicators, namely Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit Cost Ratio (BCR). The results indicate positive NPVs in all the interventions, ranging from MMK 2,704,665 per acre (teak and sesame intervention) to MMK 14,449,575 per acre (*Sterculia versicolor* plantation) over a 30-year period. The range of IRR varies from 19% in pure teak plantation to 76% in *Sterculia versicolor* plantation. Additionally, all these interventions attain a BCR of greater than 1, with the smallest value (1.7) in teak and sugarcane and the largest value (5.1) in pure teak plantation. Pure teak plantation would attain the highest BCR and the acceptable NPV, but its IRR is smallest among the interventions due to the discounting effect of late return over a long investment period. In conclusion, *Sterculia versicolor* plantation is found to be most profitable following by pineapple orchard and mango orchard.

2 Introduction

As deforestation and forest degradation are happening worldwide, particularly in developing countries, forest restoration needs to be implemented through ambitious initiatives. In restoring deforested and degraded lands, landscape approaches have been promoted to ensure sustainable land uses and to support livelihood strategies. One of the approaches is forest landscape restoration (FLR) which is known as the long-term process to restore ecological functions and enhance human well-being across deforested or degraded forest landscapes. Restoration Opportunities Assessment Methodology (ROAM) is a methodology for implementing FLR programs developed by International Union for Conservation of Nature (IUCN) in partnership with World Resources Institute (WRI). Among others, ROAM methodology emphasizes the role of restoration economic modelling and valuation to help inform decision makers of different types of restoration interventions and their associated costs and benefits. Understanding costs and benefits of FLR interventions can offer a basis for better allocation of resources within restoration program.

The government of Myanmar had made some significant efforts to restore its deforested and deforested lands during recent decades. According to the Myanmar Forest Policy (1995) and the Nationally Determined Contributions (NDC), the government is committed to increase its forest land up to 30% of total country area by 2030. To fulfill this target and diminish its deforestation rate, Ministry of Natural Resources and Environmental Conservation (MONREC) has developed a 10-year restoration program (2017-18 to 2026-27) called Myanmar Reforestation and Rehabilitation Program (MRRP). The program is being mainly implemented by the Forest Department with its own national budget. The MRRP includes a wide range of restoration activities such as establishing commercial plantations, restoring old commercial plantations, upscaling community forestry, promoting agroforestry, etc. Under the MRRP, commercial forest plantations with valuable species like teak (*Tectona* *grandis*), pyinkado (*Xylia xylocarpa*) and padauk (*Pterocarpus macrocarpus*) are being established by the Forest Department to decrease timber demand pressure on natural forests and to assure sustainable supply of teak and other hardwoods to international and domestic markets.

Moreover, participatory forest management has been initiated by the Ministry of Forestry since 1995 with the development of Community Forestry Instructions (CFIs). At present, it is the only way that local communities can get recognition and protection of customary land tenure rights over forest land. According to the CFIs which was revised in 2019, the government grants local communities a 30-year land lease with the possibility of extension, confers full commercial rights over their forest products and allows any suitable agroforestry system combining cash crops with forest trees. In some cases, community forestry is practiced to restore degraded reserved forests and protected public forests affected from encroachment by people. Thus, community forestry has been instrumental to support sustainable livelihoods on the one hand and to contribute to the increase in forest cover on the other hand.

The Restoration Initiative (TRI) Myanmar project is a child-project of the global program *The Restoration Initiative (TRI) – Fostering innovation and integration in support of the Bonn Challenge*. The goal of the 4-year project is to reverse forest degradation and deforestation and restore forested landscapes through local multi-stakeholder management. The project is being executed by the Forest Department (FD, lead executing agency) and International Union for Conservation of Nature (IUCN) in collaboration with MONREC and in partnership with The Nature Conservancy (TNC). Restoration opportunities were identified through a series of ROAM workshops at national, district and township levels. Under the project, landscape restoration interventions are being implemented in six townships, namely, Katha, Indaw, Kawlin, Tigyaing, Kanbalu and Kyunhla of Sagaing Region, and policy integration and capacity development are to be done in the whole country. In order for effective management of the project, it is still needed to determine if restoration interventions are financially viable and feasible. To fill this gap in part, this report presents cost-benefit analysis of some restoration interventions. The objectives of this cost-benefit analysis are to evaluate if an intervention type is financially viable and to determine which intervention type is more feasible.

3 Methodology

This report presents cost-benefit analysis of restoration interventions that are recommended in six township-level ROAM workshops organized in 2019. The majority of participants in each of the workshops proposed to conduct cost-benefit analysis of an intervention type most commonly practiced in their township. Therefore, six restoration interventions are considered in six project townships, namely, a pure teak plantation in Kawlin, a *Sterculia versicolor* (used to produce gum resin) plantation in Kyunhla, a mango orchard in Katha, a teak and sugarcane intervention in Tigyaing, teak and sesame intervention in Kanbalu and a pineapple orchard in Indaw. The primary data on costs and benefits of each intervention were collected using a spreadsheet in the above workshops through a group discussion of 20 participants from different villages in the township.

These data are later validated in 2020 during interviews with few local farmers and FD staff in each township. Each of restoration intervention is projected to have a time frame of 30 years for easy comparisons among the interventions. Since this analysis is conducted at the beginning of the project, future costs and benefits are not available over a 30-year period and thus are estimated using an annual discount rate (10%) based on current year values. Although the time frame is set for 30 years, costs and benefits of some crops (i.e., sesame, sugarcane, pineapple) are calculated on several crop rotations in 30 years since these crops are short in life span.

To determine financial viability of restoration interventions, this analysis uses three indicators:

1. Net Present Value (NPV) = $\Sigma (B_t-C_t)/(1+r)^t$
2. Internal Rate of Return (IRR) calculated as 0 = NPV = $\Sigma (B_t-C_t) /(1+IRR)^t$
3. Benefit Cost Ratio (BCR) = $\Sigma (B_t /(1+r)^t)/ \Sigma (C_t/(1+r)^t)$
   where C_t = cost in t year, B_t = benefit in t year, r = discount rate, t = time in years

Regarding the indicators, the decision rules are as follows: if NPV is positive, the intervention is profitable; if IRR is greater than the cost of capital (10%), the intervention is feasible; and if BCR is greater than 1, the intervention is said to be financially viable. Sensitivity analysis is conducted for all the FLR interventions to gain insights into sensitivity of the interventions to changes to the discount rate. The sensitivity analysis uses a ±3% variation either side of the annual discount rate (10%) taking into account possible interest rate fluctuations.

3.1 Limitations and assumptions

Despite many types of possible restoration interventions, this report only focuses on six FLR strategies in six project townships, meaning that these interventions may not be applicable in all project townships. The baseline land-use for all the interventions is assumed to be a deforested land covered with a few scattered non-commercial tree species and assumed a negligible baseline or opportunity cost. Thus, baseline or opportunity cost is not accounted for a given land use in all intervention types. Since the baseline land use is deforested land, it is assumed that labor cost for land clearing is required for the initial year of the intervention. There could be numerous benefits such as ecosystem services and carbon benefits from the implementation of these FLR intervention. However, this analysis only focuses on monetary benefits from forest trees and agricultural crops, and does not cover other benefits since all of these benefits should be integrated into a comprehensive economic analysis by a further broad study. While some land owners do plough by their own cattle or tractors, some others hire those for ploughing. To be consistent, it is assumed that ploughing cost needs to be paid for any intervention. In this analysis, IRR of each intervention is interpreted for a given cost of capital (10%) which refers to the lending rate of the Central Bank of Myanmar per annum.

4. Cost-benefit analysis of restoration interventions

4.1 Restoration through pure teak plantation

Kawlin is a township in Katha District and characterized as a plain topography with an area of about 1,891 km^2. According to the township profile of the General Administration Department (GAD), agricultural lands occupy 30% of the total township area; the average annual rainfall is about 1,500 mm and seasonal temperature varies from 12°C in cold season and 38°C in hot season; the principal agricultural crops are rice, sunflower, groundnut, sugarcane and various kinds of peas; about 47% of the total township area is constituted as forest lands. In degraded natural forests, it is needed to restore functionality of the ecosystems. Teak and *Xylia xylocarpa* are the commercial species that are commonly planted species in the township to restore those forested areas where they had once existed. Pure teak plantations have been established by the FD and private firms not only in the township but also in the Sagaing Region. This report presents cost-benefit analysis of pure teak plantation established by FD in Kawlin Township but the results are applicable to other townships in Sagaing Region due to consistent costs and benefits. In this analysis, it is assumed that teak plantation is established with a spacing of 9 ft × 9 ft and hence there are 540 trees/acre. According to MRRP work schedule, planting is done in rainy season and weeding operations are carried three times, two times, two times and one time in 1st, 2nd, 3rd and 4th years respectively. Fertilizer is applied in the first year and fire protection is carried out until four years from establishment. Thinning operations are assumed to be conducted at the ages of 11 and 16 years. Some maintenance activities such as camp, sign posts, survival counting, etc., are carried out in the 1st year.

The costs included in this intervention are: initial year costs for survey, land preparation, seeds and nursery practices, planting and maintenance activities; costs for weeding operations and fire protection in the first four consecutive years; thinning operation costs in 11th and 16th years; and labor cost for final harvest of teak posts. All costs other than labor costs for the final harvest were valued based on the norms that are determined by the FD for the larger-scaled teak plantation (i.e., > 50 acres) under MRRP. The unit acre cost is scale-dependent and could increase in smaller-scaled teak plantations. Although the plantation is expected to attain 80% survival, there will be 432 stems at the end of the first year and 270 stems left after the first thinning at the age of 11. The benefits are revenue from sales of 162 poles from 1st thinning at age of 11 with stumpage value of MMK 11,000/pole, 135 posts from 2nd thinning at the age of 16 with stumpage value of MMK 20,000/post and final harvest of 30 cubic tons from the plantation at age of 30 with stumpage value of MMK 2,000,000/cubic ton. Therefore, total costs and benefits from one acre of land are expected to be MMK 1,008,981 and MMK 5,115,761 over 30 years (Table 1). The NPV of MMK 4,106,781 per acre indicates that this intervention is profitable. The intervention will generate a BCR of 5.1 indicating financial viability of teak plantation. The IRR is estimated to be 19% which is greater than the cost of capital (10%), suggesting a feasible investment. On the other hand, this intervention bears a long payback period which is 16 years (Figure 2) and about 97% of total discounted cost has to be incurred before the payback period (Table 7). Therefore, this restoration option should be chosen by public and private firms. The limited benefit from this intervention is largely influenced by lower price of intermediate yields and final yield sold at local market. If there is secure local market or international market access for both intermediate yields and final yield, the higher benefits could be expected from this intervention.

Table 1: Costs and Benefits of Teak Plantation over 30 years

Description	Nominal value (MMK) Discounted @10%	Equivalent USD (USD 1 = MMK 1,315)
Costs		
- Survey	2,500	
- Land preparation	80,000	
- Seeds & nursery	86,039	
- Planting	159,550	
- Fertilizer	35,000	
- Maintenances	26,340	
- Weeding	541,679	
- Fire protection	26,151	
- Thinning	32,809	
- Final harvest	18,912	
Total costs	1,008,981	**$767**
Benefits		
- Second thinning	687,038	
- Third thinning	646,359	
- Final harvest	3,782,365	
Total benefits	5,115,761	**$3,890**
NPV	4,106,781	$3,123
IRR	19%	
BCR	5.1	

4.2 Restoration through community forestry (mango orchard)

Katha Township is situated in Katha District and covers an area of 2,242 km^2 with low-lying grounds in south-east and hilly areas in north-west. According to the township GAD, agricultural lands and forest lands constitute 22% and 47% of the total township area respectively; average annual rainfall is about 1,600 mm and seasonal temperature varies largely from 3°C in cold season and 45°C in hot season; rice, sugarcane, groundnut, sesame and various kinds of peas are commonly grown in the agricultural landscapes; among the perennial agricultural crops, mango is largely grown in the township following by rubber and coconut. In some areas where Reserved Forests and Protected Public Forests are being degraded and encroached by local people, community forestry is insisted upon and promoted by the FD to provide basic needs of local people and to have tree cover on deforested lands. With respect to species choices, mango is one of the crops preferred by the local community in fertile and well-drained soils. It is assumed in this analysis that a mango orchard is established by a planting density of 30 ft × 30 ft. Land is prepared by clearing of residual trees, ploughing, pitting in the first year. About 50 mango seedlings are needed to grow in one acre of land and they are bought at MMK 1,500/seedling. The seedlings are planted into the pits (1 ft × 1 ft × 1.5 ft) by applying organic manure. It is assumed that fertilizer application (100 kg/acre/year), pesticide application and spot weeding are done yearly. Pruning and fruit plucking are the activities assumed to be done from 6th year and later.

The assumed costs in the first year include the costs for land clearing, ploughing, pitting, seedlings, planting and manure. Yearly costs included are fertilizer, pesticide and spot-weeding. Since it is assumed that mangoes are produced from the 6th year to the 30th year and sold at a market price of MMK 400/mango, labor costs for pruning, fruit plucking and packaging and transportation cost to local market were considered in this analysis. The average yield per acre is estimated to be 3500 mangoes with a yield of 70 mangoes/tree/year starting from 6th year. The discounted net cash flow (NPV) expected from one acre of mango orchard is MMK 5,122,285 over 30 years (Table 2). This intervention is expected to have the IRR of 40% while it is expected to attain BCR of 2.4. The values of positive NPV, IRR being higher the cost of capital (10%) and BCR being greater than 1 indicate profitability, feasibility and financial viability of mango orchard. One important constraint in this intervention is the payback period which is as long as 7 years (Figure 2). Out of the total cost, MMK 974,358 is needed before the payback period (Table 7) to restore one acre of land by mango orchard. A model of integrating mango with cash crops in the earlier years could be an approach to remediate the longer payback period without financial benefits in between.

Table 2: Costs and Benefits of Mango Orchard over 30 years

Description	**Nominal value (MMK) Discounted @10%**	**Equivalent USD (USD 1 = MMK 1,315)**
Costs		
- Land clearing	200,000	
- Ploughing	50,000	
- Pitting	50,000	
- Seedlings	75,000	
- Manure	25,000	
- Planting	20,000	
- Fertilizer	729,051	
- Pesticide	155,544	
- Spot weeding	51,848	
- Pruning	123,995	
- Fruit plucking	601,375	
- Packaging	607,575	
- Transportation	867,964	
Total costs	**3,557,351**	**$2,705**
Benefits		
- Mango fruits	8,679,637	
Total benefits	**8,679,637**	**$6,600**
NPV	5,122,285	$3,895
IRR	40%	
BCR	2.4	

4.3 Restoration through community forestry (*Sterculia versicolor*)

Kyunhla is a township in Kanbalu District covering 2,670 km^2 with a topography of hills and low-lying grounds. According to the township GAD, the major land uses in the township are forest lands (60%), water bodies (12%) mainly occupied by Thaphanseik dam and agricultural lands (11%); the seasonal temperature ranges from 18°C in cold season to 43 °C in hot season with an annual rainfall of about 1,300 mm; rice, various kinds of peas, sesame, sorghum, sugarcane, etc. are the annual crops whereas *Sterculia versicolor* and coconut are the perennial crops commonly grown in the township. There are areas of degraded forests such as Indaing (*Dipterocarpus*) and semi-Indaing forests. In these areas, plantations of teak and other commercial tree species are not favorable due to drier climate with sandy and nutrient-poor soils but a conversion to a *Sterculia versicolor* plantation is potentially feasible. The assumptions in this type of restoration are that the plantation is established after land clearing, ploughing, pitting (1 ft × 1ft × 1.5 ft) with a spacing of 18 ft × 18 ft. In case of some mortality in the initial year, patching up is carried out in next growing seasons for a full stocking of 130 trees/acre. Weeding is carried out one time per year. It was assumed that resin tapping is started at the age of 6 with daily tapping for 8 months/year and continued until the age of 30.

The costs covered in this restoration intervention were operation costs (land clearing, ploughing, pitting), input costs (seedlings, organic manure, pesticides), labor costs (planting, weeding, resin tapping) and transportation cost of resin to local market. The benefit is assumed as revenue from resin of 130 trees with the average annual yield of 2 kg/tree and sold at 15,000 MMK/kg. It is expected to generate a net cash flow (NPV) of 14,449,575 MMK/acre of *Sterculia versicolor* plantation after 30 years (Table 3). The IRR for *Sterculia versicolor* plantation is 76% which is quite higher than the interest rate of 10% while the BCR is 2.2. These three indicators reveal that *Sterculia versicolor* plantation is financially viable and feasible with a higher profit. The payback period for this intervention is six years, and a discounted cost of MMK 630,539/acre is needed to invest before the payback period (Table 7 and Figure 2). As this type of intervention is the most preferred option among the community forest users, there is a high potential to restore the landscape by scaling up such a plantation. On one hand, there could be a financial gap between rich farmers and poor farmers for investing in such an intervention with a longer payback period. In spite of not being a problem for rich farmers, the initial costs could be a considerable barrier for poor farmers. Access to concessional loans could support a scale up of this intervention. On the other hand, knowledge of plantation management and market information is integral to a productive business since *Sterculia versicolor* is relatively innovative for farmers in Kyunhla and other townships.

Table 3: Costs and Benefits of *Sterculia versicolor* Plantation over 30 years

Description	Nominal value (MMK) Discounted @10%	Equivalent USD (USD 1 = MMK 1,315)
Costs		
- Land clearing	200,000	
- Ploughing	93,388	
- Pitting	52,000	
- Manure	30,000	
- Seedlings	36,400	
- Planting	20,000	
- Pesticide	331,827	
- Weeding	259,240	
- Resin tapping	11,012,406	
- Transportation	357,903	
Total costs	12,393,165	**$9,424**
Benefits		
- Resin yield	26,842,740	
Total benefits	26,842,740	**$20,413**
NPV	14,449,575	$10,988
IRR	76%	
BCR	2.2	

4.4 Restoration through conventional agriculture (pineapple orchard)

Inndaw Township is located in Katha District and is characterized by a hilly topography covering 1,899 km^2. According to the township GAD, about 52% of the total area is covered with Reserved Forests and Protected Public Forests. Of the low-lying areas, about 15% is cultivated by agriculture. The average annual rainfall is about 1,800 mm with a seasonal temperature range of 14°C in cold season to 39°C in hot season. Rice, sorghum, groundnut, sesame, sunflower, pineapple, etc. are the annual crops commonly grown across the agricultural landscapes. Local farmers cultivate pineapple in relatively humid areas. In this report, it is assumed that pineapple orchards are cultivated under rainfed condition without extra irrigation. The land is prepared by ploughing and digging pits and planting is done in double rows 2 ft apart. Spacing is considered to be 3 ft between double rows and 1.5 ft between plants, having 116,000 pineapple plants per acre of land. At the time of planting, organic manure is applied into the pits and then, mulching is done with rice husk on soil bed to retain moisture level. Hand weeding and pesticide are used to control weeds. At the time of flowering, a growth of slips occurred and some of the slips are removed to avoid the presence of more slips. It is assumed that pineapple produces three yields in the forms of ratoon crops starting from its second year and a new orchard is re-established at every four years. One acre of land is assumed to bring in 10,000 pineapples/year (i.e., 30,000 pineapples in a 4-year rotation) on average.

The costs in the intervention are that of land clearing, ploughing, pitting, planting, weeding, harvesting, slips, manure, rice husk, mulching, pesticide, slip removal, transportation. The benefit expected from this orchard is the sale of pineapples (MMK 400/pineapple) in three years of a 4-year rotation leaving the first year of rotation unproduced. The NPV expected from one acre of pineapple orchard is MMK 11,980,488 after 30 years.

The positive NPV indicates that investing in this intervention is profitable. The IRR is estimated at 64% which is demonstrates feasibility given that the prevailing cost of capital is 10%. This intervention will attain a BCR of 1.7 which is greater than 1. According to these criteria, it is evident that the pineapple orchard is a promising intervention. However, the total cost of one acre of pineapple orchard is as high as MMK 17,476,762 in 30 years. Out of the total cost, MMK 4,613,655 is needed in the initial two years to cover all the costs before the payback period which is 3 years (Table 7 and Figure 2). Although it can generate attractive benefits, the higher initial cost before the payback period may hinder the promotion of this intervention. Subsidies or grant programs in initial years will enable pineapple farmers to up-scale such a restoration intervention.

Table 4: Costs and Benefits of Pineapple Orchard over 30 years

Description	Nominal value (MMK) Discounted @10%	Equivalent USD (USD 1 = MMK 1,315)
Costs (teak)		
- Land clearing	200,000	
- Ploughing	150,265	
- Pitting	2,614,605	
- Slips	3,486,140	
- Manure	180,318	
- Planting	721,270	
- Rice husk	3,245,717	
- Mulching	360,635	
- Weeding	414,784	
- Pesticide	64,292	
- Slip removal	294,573	
- Harvesting	220,929	
- Transportation	5,523,234	
Total costs	17,476,762	$ 13,290
Benefits		
- Pineapple yield	29,457,250	
Total benefits	29,457,250	$ 22,401
NPV	11,980,488	$ 9,111
IRR	64%	
BCR	1.7	

4.5 Restoration through teak and sesame intervention

Kanbalu is a township in Shwebo District characterized by low-lying areas in the south-west and hilly areas in the north-east, covering a total area of 4,142 km^2. According to the township GAD, the land use in the township is mainly delineated to 40% of agricultural land and 44% of forest land. The climate profile is composed of an average annual rainfall of about 1,100 mm and a temperature variation from 10°C in the cold season to 43°C in the hot season. Rice, various kinds of peas, sesame, sugarcane, etc. are the principal agricultural crops in the low-lying areas of the south-west. Despite being home to a large amount of forest land, many of the forests have been lost due to encroachment by local farmers over previous decades. As such, much of the forestry area lacks adequate forest cover. As such, in the ROAM workshop, large areas of deforested lands in north-east hilly areas have been identified for restoration. The FD convinced those intruding farmers to implement community forestry granting a land lease of 30 years. One of interventions is a combination of teak and sesame. In this intervention, farmers will continue traditional sesame growing and they have to integrate 150 teak trees/acre in their community forest area wherever possible. It is assumed that 150 teak trees are planted 6 ft × 6 ft on 0.12 acres and sesame is grown in 0.88 acres per acre of land. Teak seedlings are planted by digging pits (1 ft × 1 ft × 1.5 ft) and beating up is done in next growing season. Thinning operation is conducted at the age of 16 and final harvest is gathered at the age of 30.

Regarding the teak plantation, it was assumed that land clearing, pitting, teak seedlings and planting are the initial year costs, thinning and final harvest are the operation costs of this intervention. For sesame production, the yearly costs assumed includes ploughing, manure, pesticide, labor for harvesting process, and transportation to market. The benefits in this intervention are assumed to be sesame yield estimated at 4 baskets/acre/year sold at market price of 40,000 MMK/basket. Revenues from teak includes the sale of 75 thinning posts sold at a stumpage value of MMK 15,000/post and a final harvest of 15 cubic tons at the age of 30, sold at stumpage value of MMK 2,000,000/cubic ton. The NPV from one acre of teak and sesame intervention is calculated at MMK 2,704,665 for a 30-year time frame (Table 5). The positive NPV shows that investing in this intervention is profitable. The IRR is estimated at 42%, which is viable for a given interest rate (10%). This intervention will attain a BCR of 2.3 which is greater than 1, indicating financial viability of the intervention. Based on the three criteria, this kind of intervention is said to be profitable and financially viable. The payback period is 3 years under this intervention, and the total costs required before the payback period is MMK 732,753 per acre (Table 7 and Figure 2). Due to a slow and steady trend of NPV over the time frame (Figure 2), this intervention could just be a subsistence agriculture for the livelihoods of local farmers. But, it could contribute to forest restoration in other aspects. Thus, a solution such as intensive agriculture and agro-silvo pastoral system could pave a way to keep up this intervention with improved benefits. At the same time, in order to promote forest restoration, there should be some incentives such as covering the initial costs for teak plantation and supporting livelihoods.

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Table 5: Costs and Benefits of Teak and Sesame Intervention over 30 years

Description	Nominal value (MMK) Discounted @10%	Equivalent USD (USD 1 = MMK 1,315)
Costs (teak)		
- Land clearing	200,000	
- Pitting	60,000	
- Seedlings	15,000	
- Planting	10,000	
- Thinning	19,151	
- Harvesting	9,456	
Costs (sesame)		
- Ploughing	684,394	
- Seeds	365,010	
- Manure	273,758	
- Pesticide	109,503	
- Harvesting	228,131	
- Transportation	36,501	
Total costs	2,010,904	**$1,592**
Benefits		
- Teak thinning posts	269,316	
- Teak final yield	1,891,182	
- Sesame yield	2,555,071	
Total benefits	4,715,569	**$3,586**
NPV	2,704,665	$2,057
IRR	42%	
BCR	2.3	

4.6 Restoration through teak and sugarcane intervention

Tigyaing Township in Katha District covers 1,806 km^2. According to the township GAD, about 51% of township area is comprised of forest lands such as Reserved Forests and Protected Public Forests, and 23% belongs to agricultural lands. The climate is defined by an annual rainfall of about 1,400 mm and a seasonal temperature ranging from 23°C in cold season to 42°C in hot season. The primary agricultural crops are sugarcane, rice, groundnut, sesame and various kinds of peas, etc. Among them, sugarcane is the most widely cultivated crop in agricultural landscapes and three private sugar production factories are located in the township. Moreover, in forest lands where deforestation had happened, farmers intruded into and were growing sugarcane. The FD organized such farmers and introduced community forestry in accordance with the CFIs (2019). Teak is a popular tree species to be combined with sugarcane. The FD allows community forest users to grow sugarcane if they establish 150 teak trees/acre wherever possible in the community forest land. It is assumed that 150 teak trees are planted by 6 ft × 6 ft on 0.12 acres and sugarcane is grown in 0.88 acres per acre of land. The costs for sugarcane in this intervention were costs of operations, inputs, labor and transportation costs over 30 years. It was assumed that sugarcane is needed to restart a new cycle every three years due to declines in yields. The benefits are assumed to be revenue from sales of yearly sugarcane yield. Planted teak trees will be thinned at the age of 16 and will be later harvested at the age of 30. The costs and benefits for teak plantation are assumed to be the same as those in teak and sesame agroforestry approach.

This intervention will generate an NPV of MMK 3,034,029/acre over a 30-year period and IRR of 49% (Table 6). The BCR for the intervention is 1.7, meaning that MMK 1.7 will be generated for every MMK invested within 30 years. This intervention is said to be profitable since it has the ability to generate a positive NPV, relatively higher IRR and BCR greater than 1. However, the NPV slowly and steadily increases over the time frame (Figure 2), which suggests it is an unattractive type of restoration. Additionally, the payback period in this intervention is 3 years and the total costs required before the payback period is MMK 1,136,920 per acre. From an optimistic point of view, this intervention can generate benefits from agricultural crops and forest trees, and could provide simultaneous support to local livelihoods and forest restoration. Based on filed observations, little interest was shown by local farmers to grow teak trees as due to the long time required for investment return. This may lead to a lack of proper maintenance of the planted teak trees. To support this type of forest restoration, those farmers should be provided incentives such as subsidization of initial costs and livelihood support, etc.

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Table 6: Costs and Benefits of Teak and Sugarcane Intervention over 30 years

Description	Nominal value (MMK) Discounted @10%	Equivalent USD (USD 1 = MMK 1,315)
Costs (teak)		
- Land clearing	200,000	
- Pitting	60,000	
- Seedlings	15,000	
- Planting	10,000	
- Thinning	19,151	
- Harvesting	9,456	
Costs (sugarcane)		
- Ploughing	333,582	
- Seeds	266,865	
- Planting	83,395	
- Manure	100,075	
- Fertilizer	876,024	
- Pesticide	255,507	
- Weeding	182,505	
- Harvesting	684,394	
- Transportation	1,505,667	
Total costs	4,601,622	$3,499
Benefits		
- Teak thinning posts	269,316	
- Teak final yield	1,891,182	
- Sugarcane yield	5,475,152	
Total benefits	7,635,650	$5,807
NPV	3,034,029	$2,307
IRR	49%	
BCR	1.7	

5. Summary of NPV, BCR and IRR of restoration interventions

The NPVs, IRRs and BCRs of the interventions are shown in Table 7 and Figure 1. All the interventions reveal positive NPVs showing the profitability of them all. The results also indicate the financial viability of the interventions since they would attain a BCR of greater than 1. The IRRs vary from 19% in pure teak plantation to 76% in *Sterculia versicolor* plantation. The cumulative NPVs of the interventions are presented across the time frame (30 years) (Figure 2) so as to depict their trends and payback periods. Based on our field observations, we are assured that the values of NPVs, IRRs and BCRs reflect the real situations on the ground. The sensitivity analysis shows that pure teak, teak and sugarcane, and teak and sesame are more sensitive to the discount rate than the other interventions (Table 8). If the discount rate is 7%, the NPV of these three interventions will double. If the discount rate is 13%, the NPV falls by 50%.

Table 7: Summary of discounted costs and benefits for the six restoration interventions over a 30 year period in Sagaing Region, Myanmar

Restoration Intervention	Total Cost (MMK/ acre)	Total Benefit (MMK/ acre)	NPV (MMK/ acre)	IRR (%)	BCR	Payback Period (year)	Total Cost before Payback Period (MMK/acre)
Sterculia versicolor plantation	12,393,165	26,842,740	14,449,575	76	2.2	5	630,539
	9,424	*20,413*	*10,988*				*479*
Pineapple orchard	17,476,762	29,457,250	11,980,488	64	1.7	3	4,613,655
	13,290	*22,401*	*9,111*				*3,508*
Mango orchard	3,557,351	8,679,637	5,122,285	40	2.4	7	974,358
	2,705	*6,600*	*3,895*				*741*
Pure teak plantation	1,008,981	5,115,761	4,106,781	19	5.1	16	977,501
	767	*3,890*	*3,123*				*743*
Teak and sugarcane	4,601,622	7,635,650	3,034,029	49	1.7	3	1,136,920
	3,499	*5,807*	*2,307*				865
Teak and sesame	2,010,904	4,715,569	2,704,665	42	2.3	3	732,753
	1,529	*3,586*	*2,057*				*557*

1 USD = 1,315 MMK

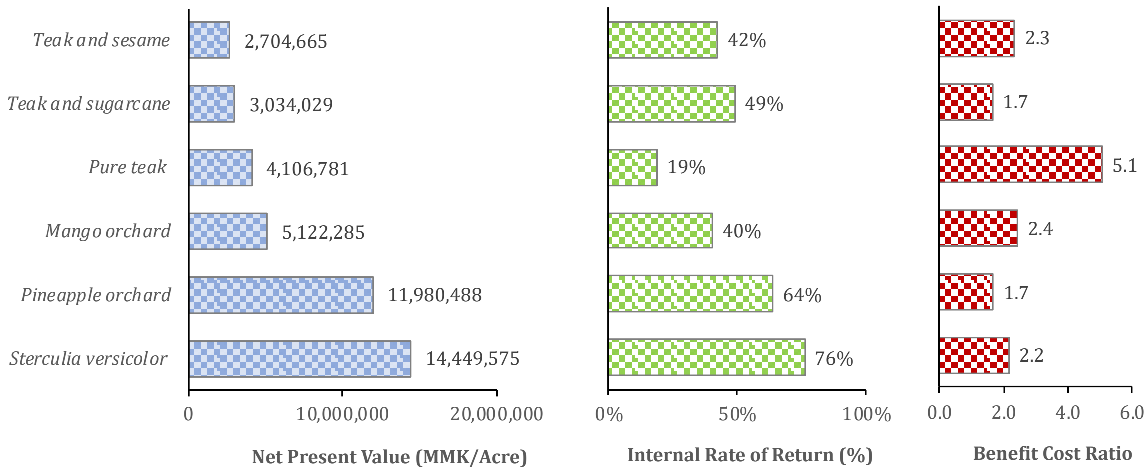

Figure 1: Comparisons of NPVs, IRRs, and BCRs of Six Restoration Interventions in Sagaing Region, Myanmar

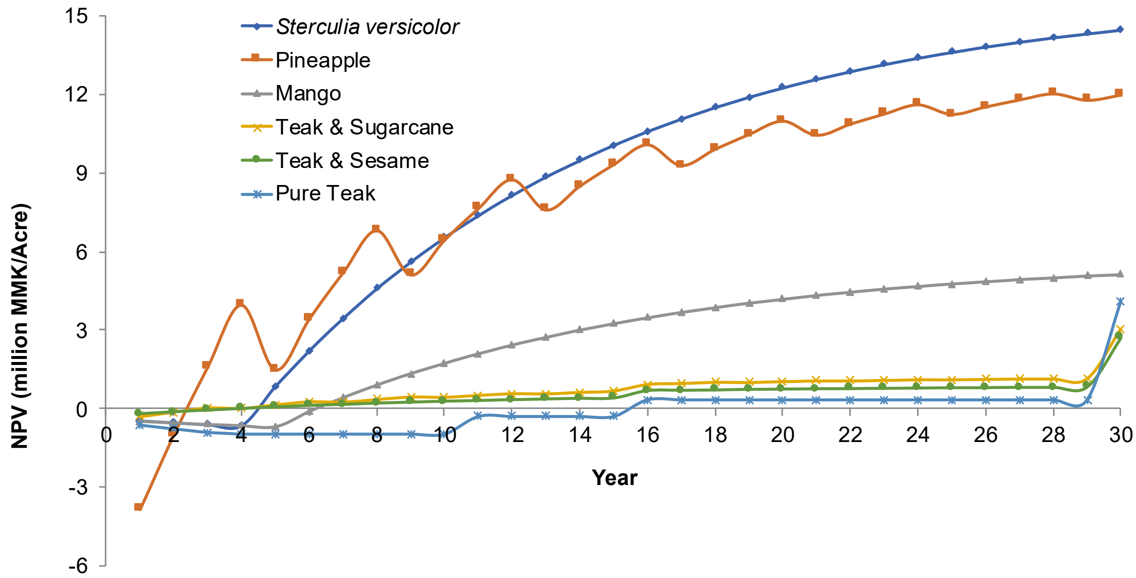

Figure 2: Trends of Cumulative NPVs of Six Restoration Interventions across the 30 year time frame in Sagaing Region, Myanmar

Table 8 - Sensitivity analysis conducted at different discount rates over a 30-year period. Change (%) in NPV is calculated based on the baseline NPV at discount rate of 10%.

Restoration Intervention	Discount Rate (10%)	Discount Rate (7%)		Discount Rate (13%)	
	NPV (MMK/ac)	NPV (MMK/ac)	Change (%)	NPV (MMK/ac)	Change (%)
Sterculia versicolor plantation	14,449,575	20,510,321	+42	10,571,990	-27
Pineapple orchard	11,980,488	16,170,313	+35	9,211,477	-23
Mango orchard	5,122,285	7,629,582	+49	3,538,027	-31
Pure teak	4,106,781	9,256,330	+125	1,715,614	-58
Teak and sugarcane	3,034,029	5,835,526	+92	1,697,900	-44
Teak and sesame	2,704,665	5,387,885	+99	1,445,054	-47

6. Conclusions

Based on the three financial indicators, all the interventions are profitable with considerable variation. Among them, *Sterculia versicolor* is observed to be most feasible generating a NPV of MMK 14,449,575/acre in 30 years. It suggests a great investment opportunity of *Sterculia versicolor* plantation if the plantation management can be properly implemented and resin yield can be linked to market. Thus, trainings on pruning and resin tapping would encourage sustainable harvesting through improved management and linkages to the market which in turn will benefit income generation for the community.

Pineapple orchard is the second-most beneficial option with a NPV of MMK 11,980,488/acre after 30 years. However, the higher total costs (MMK 4,613,655) per acre before a payback period of three years may hinder up-scaling of this intervention among farmers. The provision of subsidizes or grants in the initial years could help pineapple farmers to remediate higher costs in initial years of the restoration intervention.

Generating the NPV of MMK 5,122,285/acre after 30 years, mango orchard is found to be a third-ranking profitable intervention. However, the earlier (up to 5) years of zero returns could be a challenging aspect of the intervention for local subsistence farmers. A combination of cash crops could be considered for an alternative source of income in the earlier years.

Pure teak plantation would attain the highest BCR (5.1) out of the interventions but its NPV (MMK 4,106,781/acre) over 30 years is relatively small compared to the aforementioned options. The IRR of 19% indicates a viable investment over a longer payback period of 16 years. Therefore, this restoration option could be an investment opportunity which is usually considered by public and private firms. Market development for intermediate yields would add value to the benefits from this intervention.

Some other interventions such as teak with sugarcane and teak with sesame exhibit higher values in IRR but lower values in NPV, showing that they are profitable but less promising. Investing in intensive agriculture could be considered for more annual benefits while planted teak trees accrue benefits after many years. In order to contribute to forest landscape restoration, the costs of inputs should be provided to those farmers who are interested in agroforestry in the form of intensive agriculture.

References

Cheboiwo, Joshua & Langat, David & Muga, Meshack & Kiprop, Jonah. (2019). *Economic Analysis of Forest Landscape Restoration Options in Kenya Economic Analysis of Forest Landscape Restoration Options in Kenya*.

Food and Agriculture Organization of the United Nations (2017). *Landscapes for life: Approaches to landscape management for sustainable food and agriculture*, Rome, Italy, 47 pp.

General Administration Department (2018). *Township profiles of Katha, Inndaw, Kawlin, Tigyaing, Kanbalu and Kyunhla.*

IUCN and WRI (2014). *A guide to the Restoration Opportunities Assessment Methodology (ROAM): Assessing forest landscape restoration opportunities at the national or sub-national level*. Working Paper (Road-test edition). Gland, Switzerland: IUCN. 125pp.

IUCN (2018). *Project Document, The Restoration Initiative (TRI) Myanmar: Reversing forest degradation and deforestation and restoring forested landscapes through local multi-stakeholder management*, 122 pp.

Ministry of Environmental Conservation and Forestry (2015). *Myanmar`s Intended Nationally Determined Contributions*, Nay Pyi Taw, the Republic of the Union of Myanmar, 16 pp.

Ministry of Forestry (1996). *Myanmar Forest Policy, 1995*, Yangon, the Union of Myanmar, 7 pp.

Ministry of Natural Resources and Environmental Conservation (2016). *Myanmar Reforestation and Rehabilitation Program (2017-18 to 2026-27)*, Nay Pyi Taw, the Republic of the Union of Myanmar, 33 pp.

Ministry of Natural Resources and Environmental Conservation (2019). *Community Forestry Instructions*, Nay Pyi Taw, the Republic of the Union of Myanmar, 23 pp.

Verdone, M. (2015). *A Cost-Benefit Framework for Analyzing Forest Landscape Restoration Decisions*. Gland, Switzerland: IUCN, 42 pp.

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