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A Financial Cost-Benefit Analysis of Forest Plantation for Restoration Program in Shan State of Myanmar

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Abstract: Understanding the costs and benefits of plantations can provide a better way for resources management in restoration area. This paper focuses on the net present value (NPV) and the internal rate of return (IRR) and benefit-cost ratio (BCR) for financial performance of the plantations. A combination of secondary information survey method and field survey method for data collection was carried out in this study. On the basis of an annual discount rate of 10%, the results indicate positive NPVs, pure teak plantation would attain the highest BCR and the acceptable NPV, but its IRR is smaller than agroforestry practice due to the discounting effect of late return over a long investment period. Pure teak plantation is found to be most profitable following by agroforestry practice (teak and turmeric) and pine plantation. From a pure financial point of view, plantations should be encouraged but its long-term productivity and adverse ecological effects have to be taken into account. It also needs systematically calculation to obtain high-quality timber in the final harvest of forest plantations, but also to obtain large volume of timber to satisfy more economic benefits. The results provide valuable information for plantation policy for the government.

Keywords: Plantation, Cost-Benefit Analysis, Net Present Value, Internal Rate Of Return, Shan State

1. Introduction

Forests cover 31 percent of the global land area (Rome, 2020). The global forest area decreased by 178 million hectares between 1990 and 2020, but the demand for timber and forest products is expected to have more than triple by 2050 due to the growing world population and changing patterns of consumption (Indufor, 2012; Payn et al., 2015; WWF, 2012). Between 2015 and 2020, the rate of deforestation was estimated at 10 million hectares per year, down from 16 million hectares per year in the 1990s. In 2020, the planted forest area in the world was about 294 million hectares, accounting for about 7% of the global forest area and the rate of increase has slowed since 2010 (Payn et al., 2015). Forest plantations are mainly used in combating desertification, absorbing carbon to offset carbon emissions, protecting soil and water, maintaining biodiversity and providing rural employment. The potential for forest plantations to partially meet demand for wood and fiber for industrial uses is increasing. In several countries, a significant portion of the wood supply for industrial uses comes from plantations, rather than natural forest resources (Carle et al., 2002). Nowadays, forest plantations are mainly distributed in tropical and temperate zones especially in Southeast Asia.

Myanmar is still one of the counties in South-East Asia Region possessing rich forest resources(Thee, 2013). Forest Resource Assessment- FRA (2010) showed that 46.96% of the total country area (31.77 million hectares) is covered with different types of forest in 2010(Thee, 2013). In Myanmar, forest resources make a substantial contribution to country's economic sector both at subsistence and commercial scale, as well as in a tangible and intangible way(Chan Ko Ko et al., 2017). Forestry sector stands at the one of the largest earnings in the country through export of logs and processed timber. Like other developing countries, deforestation and forest degradation resulting from agricultural expansion, encroachment, over-exploitation, conversion of forest land into other use etc., are major issues that hinder sustainable forest management of the country. The annual deforestation rate between 2005 and 2010, accounts 0.95% of the total forest cover (*FRA 2015 Myanmar Country Report*, n.d.).

Plantation forestry has always been the supplement to the natural forest management(Naing Oo, 2013). It is stated in the 1995 Myanmar Forest Policy that existing natural forests will not be replaced with forest plantations. Plantation forestry has a complementary role to natural forest in order to control deforestation and forest degradation. Consequently, the objectives of plantation establishment in Myanmar have been to restore deforested areas, rehabilitate degraded forest lands and supply various timber yields from the natural forests. Historically, Myanmar initiated the formation of teak plantation as early as 1869 on a small scale using "taungya" method. Large-scale plantation forestry began in 1980 and about 30,000 ha of forest plantations have annually been formed by public sector since 1984. Decreasing timber supply from natural forests and inadequate resources from public sector to invest in forest plantations, call for Forest Department to encourage private sector investment in plantation forestry(Chan Ko Ko et al., 2017).

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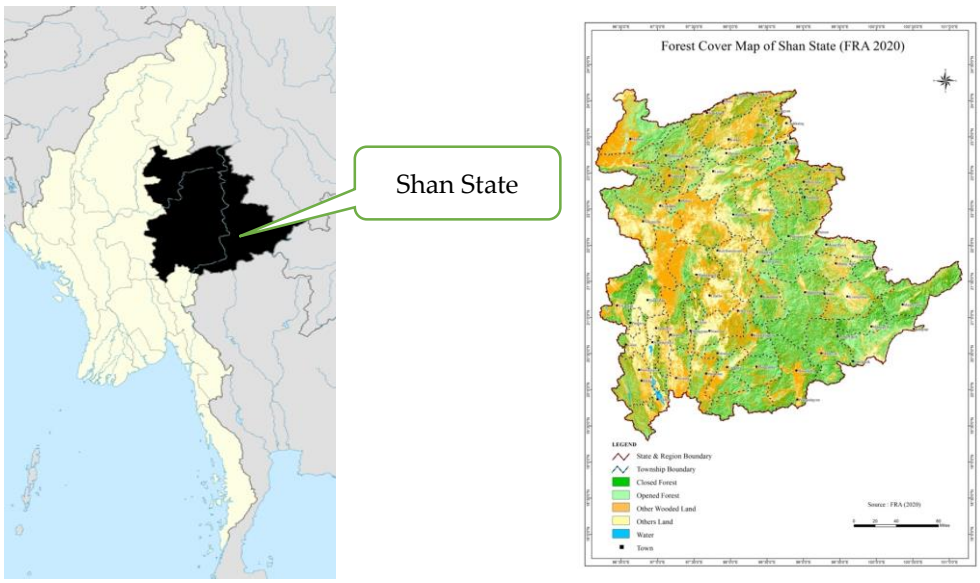
Since 2006-2007, along with the development of market-oriented economy in Myanmar, Forest Department has been encouraging private investment by national companies and entrepreneurs in commercial forest plantations with a view to supplying increasing demand of teak and other hardwoods of the country, contributing to the national economic development, and conserving environmental stability (Thee, 2013). As of February 2012, almost 44,000 hectares of private forest plantations has been established by over 100 private companies/entrepreneurs all over the country. 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. In most cases, plantations consist of only one tree species, and if a suitable species is chosen a high volume per unit can be yield, which reduces the harvesting costs (Bleyer et al., 2016). Still, the profitability of a forest plantation depends on various factors, including chosen species, land characteristics, labor costs and local as well as global wood prices (Healey & Gara, n.d.).

Forest plantations will not end its role of carbon sequester after being harvested. To promote forest development and improve management, the economic benefits are the powerful driver (Ying et al., 2010). Although the government is actively encouraging to large scale investment for plantation establishment, it is still needed to determine if plantations are financially feasible for restoration. This study attempts to analyze the cost and benefit of forest plantation in Myanmar. This study was designed to compare the economic performances of three type of plantation in a single rotation. We used three financial indicators, namely Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit Cost Ratio (BCR). The study could help the state and local governments to evaluate and formulate policies that would encourage more ecological forest plantations.

2. Materials and Methods

2.1. Study Area

The Shan Plateau is situated in north-eastern side of Myanmar is extended with mountainous upland ranging from 1000 m to 2300 m in height (Fig 1). It covers an area of 155,800 km^2 with a population of 5.8 million. Shan State takes a significant place amongst the fourteen Regions and States in the country, in terms of the biggest area of all, covering almost 25% of the whole nation, and in terms of population by far the biggest of the country (GAD 2020). The weather is a humid subtropical, dry winter climate in Shan State. The annual average temperature is at 17-29 °C and the annual rainfall is 1000-1500 mm. The area is undulating with stripped of natural forests which are subject to severe erosion. The forest area of Shan state occupies 7.5 million ha, accounting for 25.19% of Myanmar forest area. The current forest types mainly include natural forests and plantations, with abundant varieties of the forest species and plants.



(a) (b)

Figure 1. (a) The Location of Shan State and (b) Forest Cover Map of Shan State, Source: Planning and Statistics Division, Forest Department

2.2. Data Collection

Data collection was conducted from August to October in 2022. A combination of second-hand information survey method and field survey method was carried out in this study. Field survey data were collected through face-to-face interviews with local farmers about the cost of cultivating and management, amount of crops harvested, income from agroforestry practice. To examine the financial and economic feasibility of these species, the Forest Department (FD) norms were taken for assessing the costs of establishment and maintenance of forest plantations. Myanmar Timer Enterprise prices were used for valuing the final timber harvest. Since different species have different growth cycles, the years of economic benefit and harvesting are also different according to the different rotations in calculations of net present value (NPV). In the study, each of plantations is projected to have a time frame of 30 years for easy comparisons among the interventions. The second-hand information survey method is to collect the data through the existing resource inventory data and research reports, such as analysis of the yearbook and data from District Forest Management Plan which contains the information of forest species, total forest area, forest standing volume, areas of natural forests and plantations.

According to the data that were collected from the Forest Department of Shan State, there are four main plantation types in Shan State, namely commercial plantation, watershed plantation, industrial plantation and village-used plantation. According to statistics, the following table represents the area of forest plantation established by the Forest Department of Shan State from1981-2022. The study considers three different types of commercial plantations that are mostly planted in Shan State namely (i) teak plantation: *Tectona grandis* tree are planted, (ii) pine plantation: *Pinus merkusii and Pinus kesiya* trees are planted, (iii) agroforestry: teak tree and turmeric are planted together.

Table 1. The area of forest plantation established by the Forest Department of Shan State

Plantation Types	Area (acre)
Commercial Plantation	91,056
Watershed Plantation	90,878
Industrial Plantation	15,680
Village owned plantation	67,534

In order to determine financial viability of plantations, this analysis uses three indicators: (i) Net Present Value (NPV) which is calculated by subtracting the summation of discounted costs from the summation of discounted benefits; (ii) Internal Rate of Return (IRR) which is calculated using the Excel built-in function upon the annual net cash flow of the intervention; (iii) Benefit Cost Ratio (BCR) which is simply calculated as the ratio of total discounted benefit to total discounted cost over a 30-year time frame. Regarding the indicators, the decision rules are as follows: if NPV is positive, the plantation is profitable; if IRR is greater than the cost of capital (10%), it is feasible; and the restoration program is said to be financially viable if BCR is greater than 1.

2.3. Data Analysis

According to economic principles, if a forest management is wise investment, NPV of forest plantations should be positive. To better understand the management situation in Shan State, the NPVs are calculated as Table 2-4 and the calculation formula is shown as follows;

$$NPV = \sum_{y=0}^{n} \left[\frac{R_y}{(1+r)^y} - \frac{C_y}{(1+r)^y}\right] \quad (1)$$

Where NPV = the sum of revenues in each year discounted to year 0 minus the sum of costs in each year discounted to year 0

R and C = revenues and costs in the subscripted years

r = annual interest rate/100 (here r = 10%)

3. Results

3.1. Teak Plantation

Teak is one of the commercial species that are commonly planted species in the townships to restore those forested areas where they had once existed. Pure teak plantations have been established by the FD and private firms in Shan State. The study presents cost-benefit analysis of pure teak plantation established by FD. In this analysis, it is assumed that teak plantation is established with a spacing of 6 ft × 6 ft and hence there are 1,210 trees/acre. Teak has by far the longest rotation of those considered here about 30 years. According to MRRP work schedule, planting is done in rainy season and weeding operations are carried out 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 5-year intervals, at the ages of 6, 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 6th, 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 at the end of the first year, there will be 600 stems left after the first thinning at the age of 6. Thinning poles from 1st thinning at the age of 6 are not valued as they are small in size. The benefits are revenue from sales of 300 poles from 2nd thinning at age of 11 with stumpage value of MMK 20,000/pole, 150 posts from 3rd thinning at the age of 16 with stumpage value of MMK 40,000/post and final harvest of 30 cubic ton 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 1,074,283 and MMK 7,531,977 over 30 years (Table 2). The NPV of MMK 6,457,694 per acre indicates that this plantation is profitable. The plantation will generate a BCR of 7.0 indicating financial viability of teak plantation. The IRR is estimated to be 25% which is greater than the cost of capital (10%), suggesting a feasible investment. On the other hand, this plantation bears a long payback period which is 16 years (Figure 3).

3.2. Pine Plantation

Shan State is one of the natural pine lands in Myanmar. An establishment of a large-scale pine plantation was initiated in the Shan State since 1980(Chaw Sein et al., 2015). The heavily cut over natural pine area in this hilly region need to be replenished urgently to control erosion and conserve the soil. Secondly, the need for raw material for pulp can also be met as cost of extraction from accessible plantations can be much lower than that from the present inaccessible natural pine forests. Up till 2022, 19000 acres of pines have been planted in Shan State. Its potential uses include paper, furniture, firewood and resin extracts. Three weeding were carried out in the first year, two in the second and one in the third year. In this analysis, it is assumed that pine plantation is established with a spacing of 9 ft × 9 ft and hence there are 540 trees/acre.

The costs included in pine plantation compared with teak plantation are a little different in thinning operation and weeding operation. The total costs and benefits from one acre of land are expected to be MMK 625,356 and MMK 2,760,968 over 30 years (Table 3). The NPV of MMK 2,135,612 per acre indicates that this intervention is profitable. The intervention will generate a BCR of 4.4 indicating financial viability of pine plantation. The IRR is estimated to be 17% which is greater than the cost of capital (10%), suggesting a feasible investment.

3.3.Agroforestry (Teak and Turmeric)

Agroforestry has practiced in Myanmar over centuries. Recognizing the inclusion of trees on farms and in agricultural farming systems is crucial as deforestation and forest degradation in Myanmar is increasing there by accelerating societal vulnerability to climate change impacts. A growing awareness of the roles of trees in supporting rural livelihood, environmental conservation and climate change mitigation, has raised the need for targeted promotion of sustainable agroforestry practice among the decision maker. 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. The FD organized such farmers and introduced agroforestry in accordance with the CFIs (2019)(Forest Department, 2019). Teak is a popular tree species to be combined with agricultural crops. The FD allows farmers to grow crops if they establish 150 teak trees/acre wherever possible in the intruded agricultural land. Thinning operation is conducted at the age of 16 and final harvest is gathered at the age of 30.

The FD convinced those intruding farmers to implement community forestry in the form of agroforestry granting a land lease of 30 years. One of the agroforestry systems is a combination of teak and Turmeric in Kalaw township of Shan State. In this agroforestry system, farmers will continue traditional turmeric growing and they have to integrate 150 teak trees/acre in the perimeter of their farmlands or wherever possible. It is assumed that teak seedlings are planted by digging pits (1 ft × 1 ft × 1.5 ft) and beating up is done in next growing season.

The costs for turmeric growing in this intervention were costs of operations, inputs, labor and transportation costs over 30 years. Turmeric which is called “Sanwin” in Myanmar name is a crop that cultivate well in the soil. So, it needs to be well covered with the land and needed to put in irrigation water to keep the soil moist. The turmeric plant starts to develop after 120 days of cultivation. The benefits are assumed to be revenue from sales of yearly turmeric yield. Planted teak trees will be thinned at the age of 16 and will be later harvested at the age of 30. This intervention will generate an NPV of MMK 3,195,911/acre over a 30-year period and IRR of 56% (Table 4). The BCR for the intervention is 1.6, meaning that MMK 1.6 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. Additionally, the payback period in this intervention is 3 years and the total costs required before the payback period is MMK 1,253,091 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.

Table 2. Teak cash flow

No	Item	Total	Year																
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16-28	29
1	**Discounted Costs**																			
	Survey	2,500	2500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Land preparation	80,000	80000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Seeds and nursery practices	86,039	86039	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Planting related costs	159,550	159550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Fertilizers	35,000	35000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Maintenances	26,340	26340	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Weedings (3+2+2+1 times)	541,679	225000	136364	123967	56349	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Fire protection (4 years)	26,151	7500	6818	6198	5635	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Thinnings (3 times)	98,111	0	0	0	0	0	48898	0	0	0	0	30362	0	0	0	0	18852	0	0
	Final harvest (posts)	18,912	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18912
	Total cost	**1,074,283**	**621929**	**143182**	**130165**	**61983**	**0**	**48898**	**0**	**0**	**0**	**0**	**30362**	**0**	**0**	**0**	**0**	**18852**	**0**	**18912**
2	**Discounted Benefits**																			
	2nd Thinning poles	2,313,260	0	0	0	0	0	0	0	0	0	0	2313260	0	0	0	0	0	0	0
	Thinning posts	1,436,352	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1436352	0	0
	Final harvest (posts)	3,782,365	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3782365
	Total benefit	**7,531,977**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	2313260	**0**	**0**	**0**	**0**	**1436352**	**0**	**3782365**
3	NPV	6,457,694																		
	BCR	7.0																		
	IRR	25 %																		

Table 3. Pine Cash Flow

No	Item	Total	Year														
			0	1	2	3	4-9	10	11	12	13	14	15	16	17	18-28	29
1	**Discounted Costs**																
	Survey	2,500	2500	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Land preparation	80,000	80000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Seeds and nursery practices	44,926	44926	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Planting related costs	79,650	79650	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Fertilizers	17,400	17400	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Maintenances	21,340	21340	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Weedings (3+2+1 times)	282,231	150000	90909	41322	0	0	0	0	0	0	0	0	0	0	0	0
	Fire protection (4 years)	26,151	7500	6818	6198	5635	0	0	0	0	0	0	0	0	0	0	0
	Thinnings (2 times)	45,942	0	0	0	0	0	30362	0	0	0	0	0	0	15580	0	0
	Final harvest (posts)	25,216	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25216
	Total cost	**625,356**	**403316**	**97727**	**47521**	**5635**	**0**	**30362**	**0**	**0**	**0**	**0**	**0**	**0**	**15580**	**0**	**25216**
2	**Discounted Benefits**																
	Thinning posts	239,32	0	0	0	0	0	0	0	0	0	0	239392	0	0	0	0
	Final harvest (posts)	2,521,576	0	0	0	0	0	0	0	0	0	0		0	0	0	2521576
	Total benefit	**2,760,968**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**239392**	**0**	**0**	**0**	**2521576**
3	NPV	2,135,612															
	BCR	4.4															
	IRR	17 %															

Table 4. Agroforestry (Teak and Turmeric) Cash flow

Year	Description	Nominal value (MMK) Discounted @10%
	Costs (teak)	
1	- Land clearing	200,000
1	- Pitting	60,000
1	- Seedlings	15,000
1	- Planting	10,000
16	- Thinning	19,151
30	- Harvesting	9,456
	Costs (Sanwin)	
1,4,7,10, 13,16,19, 22, 25, 28	- Ploughing	379,070
1,4,7,10, 13,16,19, 22, 25, 28	- Seeds	303,256
1,4,7,10, 13,16,19, 22, 25, 28	- Planting	94,768
1,4,7,10, 13,16,19, 22, 25, 28	- Manure	113,721
1 to 30	- Fertilizer	995,482
1 to 30	- Pesticide	290,349
1 to 30	- Weeding	207,392
1 to 30	- Harvesting	777,720
1 to 30	- Transportation	1,710,985
	Total costs	5,186,351
	Benefits	
16	- Teak thinning posts	269,316
30	- Teak final yield	1,891,182
1 to 30	- Turmeric (Sanwin) yield	6,221,764
	Total benefits	8,382,262
	NPV	3,195,911
	IRR	56%
	BCR	1.6

4. Discussion

4.1. NPV and IRR of Teak

Table 2 shows that the NPV of Teak in Shan State is 6,457,694 kyats per acre , given a 10% discount rate, and the internal rate of return(IRR)is 25%, greater than the 10% discount rate, which states that Teak's cost of capital should be accepted, in other words, the rate of return on Teak plantation is far greater than the return of 10% of opportunity-cost rate , and it will result in choosing the investment of Teak that will maximize the value added to Shan State.

4.2. NPV and IRR of Pine

As Table 3 shows, Pine plantation returns are more than total costs, and the NPV is 2,135,612 kyats per acre with the 10% discount rate, the IRR is 17 %, exceeding the cost of capital, and the Pine plantation is also accepted in Shan State.

4.3. NPV and IRR of Agroforestry (Teak and Turmeric)

Similarly, Table 4 illustrates that the NPV of Teak and Turmeric in Shan State is 3,195,911 kyats per acre with an IRR of 56 %, far greater than the 10% discount rate, and the result therefore is acceptance for the investment in Shan State.

The NPV, IRRs and BCRs of the plantations are shown in Table 5 and Figure 2. All the plantations reveal positive NPVs showing the profitability of them all.

Table 5. Summary of discounted costs and benefits for the following plantation over a 30-year period in Shan State of 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)
Pure teak plantation	1,074,283	7,531,977	6,457,694	25	7.0	16	2,313,260
Pine plantation	625,356	2,760,968	2,135,612	17	4.4	16	403,316
Teak and Turmeric (agroforestry)	5,186,351	8,382,262	3,195,911	56	1.6	3	1,253,091

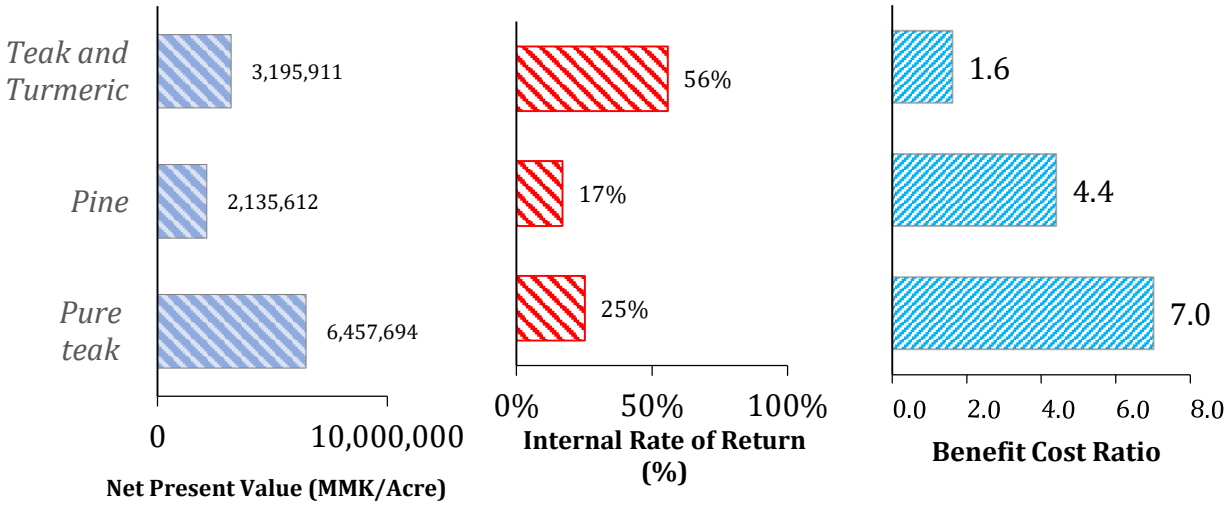


Figure 2. Comparisons of NPVs, IRRs and BCRs of three plantations in Shan State of Myanmar

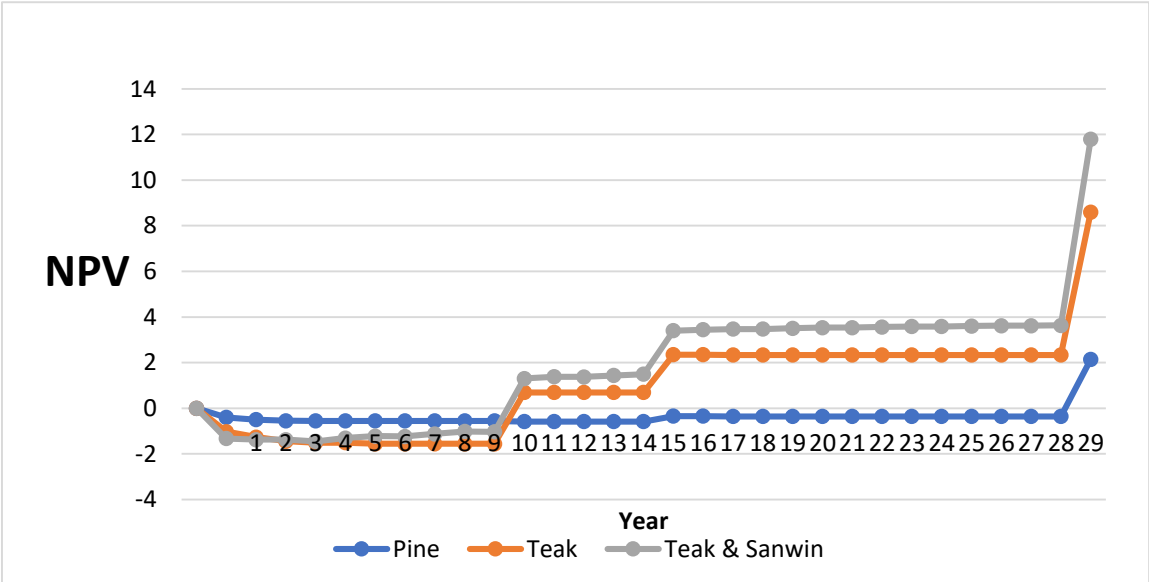


Figure 3. Trends of cumulative NPVs of three major plantations across the time frame (30 years) in Shan State of Myanmar

5. Conclusions

This paper calculated NPVs of the three major plantations in Shan State by net-present-value method. Based on the three financial indicators, all the interventions are profitable with considerable variation. Through the comparison and the analysis of the benefits, the IRR of Agroforestry systems such as teak with turmeric come highest at 56 % and Teak plantation' IRR comes next at 25 %and pine is at 17 % respectively. As such, the management benefit of agroforestry system yields the best returns on capital. Agroforestry systems such as teak with turmeric

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. A combination of cash crops could be considered for an alternative source of income. 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.

Pine plantation exhibit higher in BCR but its NPV over 30 years is relatively small compared to agroforestry practice. Pure teak plantation would attain the highest BCR (7.0) and NPV (MMK 6,457,694/acre) out of the interventions. The IRR of 25% 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 benefit from this intervention. It could be more benefits by establishing forest-based industries rather than just selling raw timber from plantations.

The expected financial profitability affects the decisions about which methods to use for plantation establishment, more than do the impacts on social welfare or income distribution. From the economic point-of-view, forest plantations should only be established on sites with a low opportunity cost. A key issue in many Southeast Asian countries, among them Thailand, will be to balance wood production where the management of natural forests and the production of wood in forest plantations are combined in order to meet the demand for high quality timber and fast-growing wood (Niskanen, 1998). In conclusion, selection of rehabilitation technique should be based on the case-by-case situations. From a pure financial point of view, plantations should be encouraged but its long-term productivity and adverse ecological effects have to be taken into account. Zhang pointed out that cultivating requires stability, time and the willingness to accommodate both the needs of people and the pace of nature and moreover, it should pay attention to forest layout and ecological issues in forestry development(Ying et al., 2010). It needs systematically calculation to obtain high-quality timber in the final harvest of forest plantations, but also to obtain large volume of timber to obtain more economic benefits. Therefore, systematic calculation should be considered on spacing, number of plants and the expected final yield.

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