A COMPARATIVE STUDY ON SOCIAL AND FINANCIAL CONTRIBUTIONS OF REMNANT NATURAL FORESTS AND PLANTATION FORESTS IN THE DRY ZONE; A CASE STUDY OF KYAUKPADAUNG AND TATKON TOWNSHIPS

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ABSTRACT

Dry zone of the central Myanmar is being rehabilitated by using two different rehabilitation measures; plantation establishment and conservation of remnant natural forests. Both measures are of crucial importance for the dry zone rehabilitation as these contributes social, economic and ecological benefits. This research paper presents the social and financial contributions of the two rehabilitation measures to the local people and the Forest Department (Dry Zone Greening Department) in a comparative way. Based on the research findings, suitable recommendations are also presented to assist the successful implementation of the dry zone rehabilitation.

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1. INTRODUCTION

Arid and semi-arid regions of Myanmar, so called dry zone, are located in the central part of the country. The dry zone covers three civil administrative regions, namely lower Sagaing, Mandalay and Magwe Divisions, and it has an area of 8,724,184 ha. There are 11.3 million inhabitants (approximately one-third of the country's population) in the dry zone. It is also one of the most important agricultural areas in the country, producing cash crops such as peas, beans, oil crops etc. and supporting half of the national cattle population (Soe Myint, 1995).

Forestlands in these areas have been progressively encroached by the rural population to satisfy their needs of fuel, other forest products and agricultural purposes. As a consequence, availability of fuelwood and other forest products is increasingly difficult and even old tree stumps and roots are being dug up and used as fuel (Soe Myint, 1995). This way of life style forced the people to encroach on reserves and protected forests at least for their subsistence consumption resulting in desert-like-formation in the driest parts of the dry zone.

The Forest Department has tried to prevent desertification and forest degradation through conservation approaches successive periods. In 1994, "Greening of the Nine Critical Districts of the Dry Zone Project" was initiated and implemented with energetic effort. It was targeted mainly to tackle the fuelwood shortage and to combat widespread deforestation across the dry zone.

Prior to 1994, plantation establishment had been the only rehabilitation measure in the dry zone. However, after initiating greening project, conservation of remnant natural forests has been adopted parallel to the plantation establishment because protection against human, cattle and fire has been found to be very effective in improving degraded forests.

Generally, both rehabilitation techniques are of crucial importance for regreening of the dry zone because these contribute ecological, economic and social benefits.

Within the framework of this study, the author mainly concentrates on contributions of remnant natural forest and *Eucalyptus camaldulensis* plantations in terms of social and financial benefits to the local people and the Forest Department in a comparative way.

2. OBJECTIVES OF THE STUDY

The specific objectives of this study are:

(1) to investigate the contributions of dry zone plantations (*Eucalyptus camaldulensis*) and those of conservation of remnant natural forest in terms of NTFPs to the local people and

(2) to examine the financial returns of dry zone plantations (*Eucalyptus camaldulensis*) and conservation of remnant natural forests.

2.1. Criteria for Objectives

The following criteria were adopted to support the set objectives.

Criteria for objective 1

Availability and consumption of:

- fuelwood;
- building materials
- agricultural implements
- fodder and grazing
- medicinal plants
- bush meat

Criteria for objective 2

- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Benefit Cost Ratio (BCR)

3. PROBLEM STATEMENT OF THE STUDY

Although the Forest Department has been implementing dry zone regreening (project) since 1994, the effects (i.e. social and financial) of adopted rehabilitation techniques have not been assessed. It is necessary to know beneficial and adverse effects of each technique to support the dry zone rehabilitation effectively. Lack of information regarding the contributions of conservation of natural forest and plantation establishment may lead to wrong decision in choosing the best rehabilitation measure in the dry zone. In addition, values of the forests (social, financial and ecological value) may be under estimated due to lack of reliable data.

4. LITERATURE REVIEW

4.1. Plantation Establishment

The world has about 3,870 million ha of forest, of which 95 percent are natural forest and 5 percent are forest plantations (FAO, 2001). Forest plantations are raised world-wide, with the aim not only to rehabilitate the degraded lands but also to obtain high yield from minimum unit area (Evans, 1997). Plantations often have much higher productivity of some major products than natural forest. In many commercial timber plantations, yield of 15 to 30 $m^3ha^{-1}yr^{-1}$ may be reached as against 1 m^3 $ha^{-1}yr^{-1}$ in natural forest (Luna, 1989). Table 2.3 shows the average annual rate of regional plantation areas up to the year-end 1990.

Table (1) The Average Annual Rate of Regional Plantation Areas up to the Year-End 1990

Regions	Average annual rate (,000 ha)
Tropical Africa	127
Tropical Latin America	373
Tropical Asia and Pacific	2,112

Source: FAO forestry paper 128, 1995 (modified by author)

The Eucalyptus genus takes the largest share of plantations in the tropical world (FAO, 1995). However, it has been criticised and even restricted planting for three main concerns (Evans, 1982): (1) excessive water use and depression of food crops grown nearby; (2) suppression of ground vegetation and resulting unsuitability for soil erosion control; and (3) generally poor wildlife value, even by plantation standard.

Nevertheless, plantation forestry provides employment opportunities for farm families and landless. A major off-farm employment in some rural areas is found in forestry related activities. The plantation alone has found to generate about 100-150 man-days employment with 1000-1600 plants planted per hectare in the plantation year (Mishra, 1997). However, the employment generated on raising plantations varies with species, site conditions, spacing, techniques used for site preparation, types of fencing etc.

Two possible risks, susceptibility to diseases and pests, and maintenance of long-term productivity, are associated with monocultural plantations whenever these are used (Evans, 1982). A massive build-up of a pest or disease is one of the most serious dangers to destroy plantations because the uniformity and the extent of a plantation are an enormous food source for the pests. Long-term productivity of the plantation is an important issue in plantation forestry because productivity between rotations can be changed due to biotic and abiotic factors (Evans, 1982).

From ecological point of view, plantation consists of few species, often only one or two. Homogeneous plantations are less rich in fauna. As vegetation type becomes simpler, biodiversity generally diminishes (Evans, 1982). Although most of the forestry plantations are established on degraded or non-forested lands and generally they contribute to site reclamation, there is legitimate concern that plantation forestry may cause certain type of ecological deterioration (Evans, 1982).

4.2. Conservation of Natural Forest

Natural forests have always played an important role in the lives of local residents and provide the people with food, building materials and numerous other products. Income earning opportunities for the local people are also found in complementary activities such as the processing and sale of non-timber forest products. Apart from direct benefits, forest also fulfils public welfare functions

which are at least equally important (Lamprecht, 1989); these include providing shade for human and animals, protecting soil against wind and water erosion, conserving the fertility of the soil, protecting against wind and beneficial hydrological effects. Table 2.4 shows natural forests and plantation forests area by region up to the year-end 2000.

Table (2) Forest Area by Region up to the Year-End 2000

Region	Land area *(mil. ha)*	Total forest (natural forests and forest plantations)			Natural forest *(million ha)*	Forest plantation *(million ha)*
		Area *(mil. ha)*	% of land area	% of world's forests		
Africa	2,978	650	22	17	642	8
Asia	3,085	548	18	14	432	116
Europe	2,260	1,039	46	27	1,007	32
North and Central America	2,137	549	26	14	532	18
Oceania	849	198	23	5	194	3
South America	1,755	886	51	23	875	10
World Total	**3,064**	**3,870**	**30**	**100**	**3,682**	**187**

Source: FAO, The Global Forest Resources Assessment, 2001

The world's natural forests have continued to be converted to other land uses at a very high rate. During the 1990s, the total loss of natural forests (i.e. deforestation plus the conversion of natural forests to forest plantations) was 16.1 million hectare per year, of which 15.2 million hectare occurred in the tropics (FAO, 2001).

From ecological point of view, natural forest provides wide range of tree species diversity (biological diversity). Even in dry forests, it is rare for one species of tree to make up more than 10 per cent of the total, whereas in a plantation forest, all trees in a stand are usually only one species. (Evans, 1982).

From economic point of view, the opportunity for profitable investment in conservation of natural forest is very low due to its low productivity (Luna, 1989). The sustainable use of a renewable natural resource base is more limited in dry zone than other regions because harsh environmental conditions limit availability of water and growth conditions (Soe Myint, 1995).

5. METHODOLOGY

5.1. Field Research

This study was carried out in the form of field research. Field research is not one particular technique, but more like an umbrella of activities beneath which any technique may be used for gaining the desired knowledge, and for process of thinking about this information (Schatzman & Strauss, 1973).

Field data collection was mainly based on exploratory social survey research method. The purpose is to analyze the actual inter-links between the forest and the local people. When conducting field research, the author directly talks with the respondents in a certain locality, observes them and interacts with them over a certain period to gain an intimate understanding of their situations.

The author selected two villages for a more detailed case study in relation to the contributions of natural forest and plantation to the local community (see selection criteria in 5.2). A case study is one of the several ways of doing field research especially in social sciences. This involves on in-depth examination and gets more details on one or few cases. According to Yin (1988), a case study is an empirical inquiry that allows an investigation to retain the holistic and meaningful characteristics of real events.

5.2. Selection of the Study Area

As the total area of the dry zone is 77,700 km^2, it was not possible to carry out a representative field study for the whole area due to time and financial constraints. Therefore, the author selected two villages, namely Shwesidaing and Kinthar, for questionnaire survey to observe the contributions of natural forest and plantation forests to the livelihood of the local people.

The selection was based on the following criteria:

(1) both villages should have more or less similar socio-economic status;
(2) the distance between villages and forests (i.e. natural forest and plantation) should be approximately equal;
(3) size of villages (number of households) should be approximately equal and
(4) the households from both villages should be engaged in agriculture and forestry activities.

Shwesidaing village is located about 2.4 km from the natural forest of Koekwe Reserved Forest in Kyaukpadaung Township. The forest covers an area of 2,458 hectare (ha) of which 202 ha have been conserved since 1996-97. Kinthar village is located about 3 km from the plantations of Yezin Protected Forest in Tatkon Township. In this Township, an area of 2,761 ha of plantations was established between the years 1994 and 2001. Initially, in the year 1994, the plantation covered an area of 202 ha. Next to the plantations, there is a Dry Deciduous Forest, which is about 5-10 km away from the village.

5.3. Survey Method

Under this study, field data were collected through two different activities i.e. questionnaire survey and forest inventory.

5.3.1. Questionnaire survey

The survey covered 34 respondents out of 113 households (i.e. 30 % of households) in Shwesidaing village and 37 respondents out of 124 households (i.e. 30 % of households) in Kinthar village. The sampling ratio was based on Neuman (1994). Firstly, the names of household heads were listed. Each name was written in separate card and then respondents were randomly selected by drawing. Finally, respondents were interviewed. Questions were posed in face-to-face interview to the respondents of both communities (see questionnaire in Annex 1).

In addition, 75 respondents from different strata of the "society" were also interviewed to gain their perspectives on two different rehabilitation techniques in relation to non-market benefits (see questionnaire in Annex 1). Out of 75 respondents, 20 dominant respondents were selected from two villages (10 from Shwesidaing and 10 from Kinthar village). Other 25 respondents fall under the category "visitor" (i.e. the people who were visiting the Popa Mountain Park nearby the study area during the time of field survey).

Another 10 respondents were selected from the forest staffs who were working in the dry zone rehabilitation activities. The remaining 20 respondents were religious persons living in different parts of the dry zone and traders engaged in NTFPs sale around the study area respectively.

To calculate the average consumption of fuelwood, building material, agricultural implements, fodder, medicinal plants and bush meat by the households, the amount of each product consumed by the households were summed up and then divided by total households. The results were expressed as an average consumption of fuelwood, building materials, and agricultural implements etc. by the households.

$$\text{Ave: consumption of each item of NTFPs by the households} = \frac{\text{Sum of average consumption of each item of NTFPs}}{\text{Total number of households}}$$

5.3.2. Forest inventory

An area of 1.25 ha, as the representative area of this research, was selected from 202 ha of remnant natural forest and *Eucalyptus camaldulensis* plantation. Then five sample plots were randomly taken within the selected area. Each sample plot has 0.25 ha of 50m x 50 m. One sample plot consists of 25 quadrats (sub-plots)

of size 10 m x 10 m. Survey was carried out in all quadrats for all trees with DBH ≥ 5 cm.

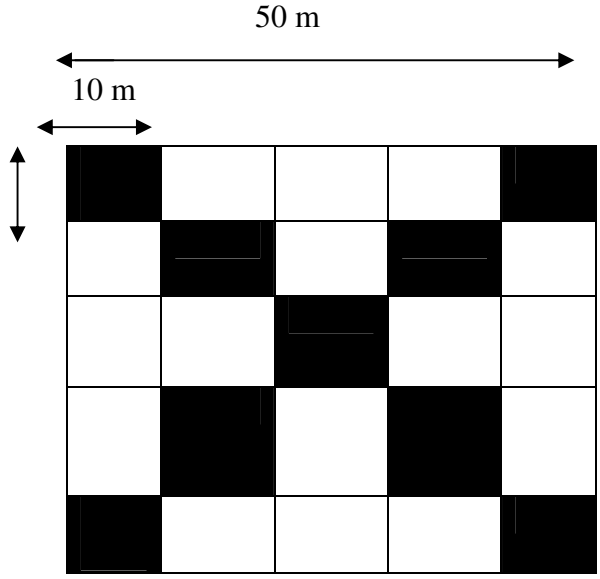

Figure 1. Layout of sample plot

5.4. Financial Analysis

Based on the forest growth data, which were obtained by conducting one short inventory, standing volume per hectare of the remnant natural forest and that of plantation were calculated. Financial data including inputs and outputs of various forestry operations were gathered from the records maintained at the respective township offices of the Dry Zone Greening Department and those of Forest Department. Indicators used in the financial analysis were Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit Cost Ration (BCR). The author used a guiding rate of return of 8 percent per year for the calculation of NPV of natural forest and plantation. In financial analysis, the author assumed that all the future prices of products (i.e. posts and poles) remain constant at the year 2002 price level and the assumptions were made as realistic as possible. The following equations were adopted to calculate the NPV, the IRR and the BCR.

Net Present Value (NPV)

$$\text{NPV} = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+i)^t}$$

where, NPV = Net Present Value (Kyat)
B_t = Benefits (Kyat)
C_t = Costs (Kyat)
n = rotation age (year)
i = discount rate

Internal Rate of Return (IRR)

$$IRR = \text{Lower Discount Rate} + \left(\text{Difference between thediscount rates}\right)\left(\frac{\text{Present worth of incremental net benefit stream (cash flow) at the lower discount rate}}{\text{Sum of the present worth of the incremental net benefit streams (cash flow) at the lower discount rate, signs ignored}}\right)$$

Benefit-Cost Ratio (BCR)

$$BCR = \frac{\text{Total discounted benefits}}{\text{Total discounted costs}}$$

6. RESULTS AND DISCUSSIONS

6.1. Social Contributions (Non-Timber Forest Products)

6.1.1. Availability and consumption of fuelwood

The main type of energy used in the study areas, Shwesidaing and Kinthar villages, is fuelwood and it accounted for 65 % of households' energy consumption (Thaung Naing Oo, 2002). Table 3 shows different sources of fuelwood collected by the households from two villages.

Table (3) Different sources of fuelwood collected by the households

Sources of fuelwood	Shwesidaing	Kinthar
	% of availability	% of availability
Natural Forest	65.1	58.8
Plantation	0	0
Home Garden	4.4	2.7
Farm	30.5	38.5
Market	0	0
Total	**100**	**100**

Source: Field survey, 2002

According to the results, people from both villages collected considerable amount of fuelwood (i.e. 65.1 % and 58.8 %) from the natural forests and a small amount of fuelwood were gathered from their home gardens. They obtained agricultural residues from their farms, and used to fulfill their energy requirement.

In order to express the amount of consumption of fuelwood by the households in financial value, local market prices of fuelwood (14 inches in length and 18 inches in mid-girth) has to be used (see market prices in Annex 2). The financial values of fuelwood consumed by the households are clustered into four groups as shown in Figure 2.

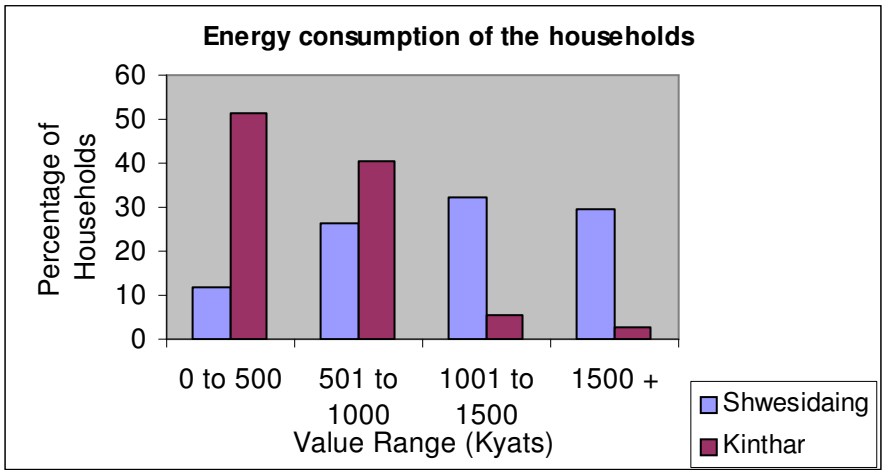

Figure 2 Monthly consumption of fuelwood in financial value by the households

The results indicate that the majority of households from Shwesidaing village (about 65 %) consumed fuelwood worth above 1.001 Kyats per month and the rest consumed below 501 Kyats in financial worth. In Kinthar village, majority of the households (about 90 %) spent below 1.000 Kyats per month for their household energy.

6.1.2. Availability and consumption of building materials

In the study areas, rural people have long been residing in or in areas adjoining the forests and they become forest dependent and forest dwellers for their basic needs. Table 4 shows different sources of building materials collected by the households.

Table (4) Different Sources of Building Materials Collected by the Households

Sources of building materials	Shwesidaing			Kinthar		
	Post & Pole (%)	Roofing (%)	Fencing (%)	Post & Pole (%)	Roofing (%)	Fencing (%)
Natural Forest	91	100	85.3	65	32	0
Plantation	0	0	0	0	0	0 0
Home Garden	0	0	0	0	0	0
Farm	0	0	0	0	0	0
Market	9	0	14.7	35	68	100
Total	**100**	**100**	**100**	**10 0**	**100**	**100**

Source: Field Survey, 2002

The results in Table 4 show that villagers collected building materials for subsistence consumption mainly from natural forest and few amount of these were purchased from the local market. Plantations could not provide building materials to the local people at all. Based on the market prices, the financial values of building materials consumed by the households are clustered into four groups as shown in Figure 3

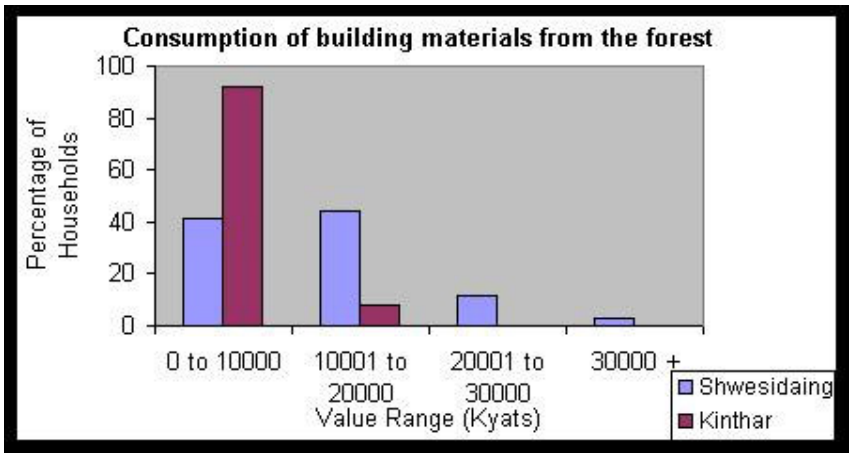

Figure 3. Annual consumption of building materials in financial value by the households

It was obvious that about 60 % of the Shwesidaing community consumed above 10.001 Kyats per year and about 40 % spent below 10.000 Kyats per year for building materials. In Kinthar village, about 90 % of the community consumed not

more than 10.000 Kyats per year for building materials and only 10 % of households could spend between 10.001 Kyats and 20.000 Kyats per year.

6.1.3. Availability and consumption of agricultural implements

As agriculture is the major employment for the rural households, the materials used in agricultural activities are of crucial importance for the rural people. In both villages, people are still utilizing traditional implements for agricultural activities, which are manually performed. Table 5 shows different sources of agricultural implements collected by the households.

Table (5) Different Sources of Agricultural Implements Collected by the Households

Sources	Shwesidaing						Kinthar					
	A (%)	B (%)	C (%)	D (%)	E (%)	F (%)	A (%)	B (%)	C (%)	D (%)	E (%)	F (%)
Natural Forest	100	100	100	71	100	91	76	76	76	74	76	74
Plantation	0	0	0	0	0	0	0	0	0	0	0	0
Market	0	0	0	29	0	9	24	24	24	26	24	26
Home Garden	0	0	0	0	0	0	0	0	0	0	0	0
Farm	0	0	0	0	0	0	0	0	0	0	0	0
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field survey, 2002

(Key words: A = Shaft of harrow, B = Harrow's tooth, C = Stock of a plough, D = Log of harrow, E = Plough beam, F = Yoke)

For both communities, agricultural implements were obtained from two sources; the natural forest and local market. In Shwesidaing village, the people harvested almost all of these implements and Kinthar community fetched 76 % of their requirements from the natural forest. Some items had to be purchased from the market due to particular choice on species and sizes. Both communities did not obtain agricultural implements from the forest plantations. The consumption of agricultural implements by the households generally depends on the farm size. Based on market prices of each item, financial values of agricultural implements consumed by the households are clustered into four groups as shown in Figure 4.

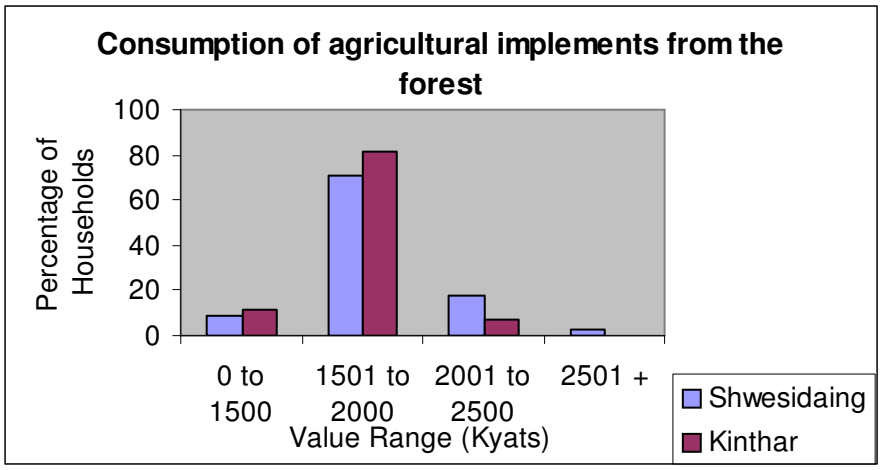

Figure 4. Annual consumption of agricultural implements in financial value by the households.

According to the results presented in Figure 4, the annual consumptions of agricultural implements by the households of both villages are not different. Since households have more or less the same size of farms, the amount of items needed for agricultural activities are about the same.

6.1.4. Availability and consumption of fodder

In the study area, trees are mainly used as fodder for cattle. Rural people obtained fodder by collecting from the forest rather than purchasing from the market. Table 6 shows different sources of fodder collected by the households.

Table (6) Different Sources of Fodder Collected by the Households

Sources of fodder	**Shwesidaing** (amount of fodder in %)	**Kinthar** (amount of fodder in %)
Natural forest	77	0
Plantation	0	0
Farm	16	70.3
Common grazing land	0	0
Home garden	5	0
Market	2	29.7
Total	**100**	**100**

Source: Field survey, 2002

The results show that Shwesidaing community fetched 77 % of their fodder requirements from the forest. However, Kinthar community had to rely on agriculture residues of the farm for their cattle because of less accessibility to the

forest. They could not frequently visit the natural forest to collect fodder. In both villages, the communities could not achieve the fodder from *Eucalyptus camaldulensis* plantations due to lack of undergrowth suitable for cattle. In addition, eucalyptus species are not a kind of fodder and if the Forest Department plans to grow some fodder tree species, local people can benefit from these plantations.

In both communities, each household usually collected fodder only for two cows, which work in the farm for ploughing and carrying fuelwood for the households. Others were set free in the forest or on the common grazing land. Therefore, each household needed 3 bundles of fodder per day for working cattle (one bundle of fodder = 8 viss = 12.8 kg). If they purchase these fodders in the market, it will cost 6,300 kyats per month. In this case, financial value of grazing is not included.

6.1.5. Availability and consumption of medicinal plants

People from villages collected medicinal plants from the forest for their health problems. However, it is not easy to quantify what amount of medicinal plants they collect per month or per year because whenever the need arises, normally they visit the forest to look for relevant medicinal plants just for immediate use. People rarely keep the medicinal plants at home. Therefore, the consumption of medicinal plants could not be quantified. Table 7 shows percentage of households, which collected medicinal plants and which did not collect.

Table (7) Percentage of Households, which Collected Medicinal Plants and which did not Collect.

Category	Shwesidaing	Kinthar
Percentage of households which collected medicinal plants	67.7	21.6
Percentage of households which did not collect medicinal plants	32.4	78.4
Total	**100**	**100**

Source: Field survey, 2002.

It was found that 67.6 % and 32.4 % of households from Shwesidiang and Kinthar villages respectively collected medicinal plants from the natural forests respectively. Similarly, plantations could not provide medicinal plants to the local people because of lack of undergrowth and natural regeneration of indigenous species.

6.1.6. Availability and consumption of bush meat

Forests provide an important source of meat in both rural and urban household diets. The availability of bush meat for households varies considerably depending on the distance between villages and the source of supply. Table 8 shows consumption of bush meat by the households in both communities.

Table (8) Monthly Consumption of Bush Meat by the Households

Sources	Swhesidaing		Kinthar	
	% of hh collecting bush meat*	Amount (kg/month)	% of hh collecting bush meat*	Amount (kg/month)
Natural forest	41.7	2.68	27	2.05
Plantation	-	0	-	0

Source: Field survey, 2002

*the rest of households did not collect bush meat.

People from both villages obtained bush meat only from the natural forests and monthly consumption in households is more or less the same. They said that bush meat may be obtained from the plantations (i.e. *Eucalyptus camaldulensis* plantation) but it is very rare because plantations are not good habitats for the wild animals. The market price of bush meat is almost the same like other type of meat (e.g. pork, beef, etc.). It is estimated that Shwesidaing village and Kinthar village will have to spend about 1,340 Kyats per month respectively if the people purchase bush meat from the market.

6.1.7. Composition of calculated average income of households

Occupation is an important parameter as it determines the existing professions and consequently the sources of income for households. Table 9 shows composition of calculated average income of households.

Table (9) Composition of Calculated Average Income of Households

No.	Source of income	Consumption pattern	Shwesidaing	Kinthar
			% of income	% of income
1.	Agriculture	Market	42.22	44.84
		Subsistence	17.11	22.42
2.	Livestock	Market	25.32	4.58
		Subsistence	*(G +) 8.44	*(G +) 1.53
3.	NTFPs	Market	0	0
		Subsistence	**(M+) 0.94	**(M+) 0.69
4.	Home garden	Market	0	0
		Subsistence	6.98	4.03
5.	Other off-farm	Market	6.99	21.9
		Subsistence	0	0
	Total		**100**	**100**

Source: Field survey, 2002

* (G +) = the financial value of grazing could not be calculated

** (M +) = the financial value of medicinal plants could not be calculated.

According to the results presented in Table 9, agriculture is the major source of income earning activity in both villages. Over 50 % of household income were generated from selling farm products but household members usually stock about one-third of total farm products for subsistence consumption.

Concerning the income from livestock breeding, it was obviously found that Shwesidaing community earned 33.75 % of the average income by this activity. However, Kinthar community received only 6.1 % of their average income. Since Shwesidaing community has access to the natural forest, people could collect fodder and set free livestock for grazing free of charge. Consequently, they could raise livestock for their extra income as much as they wanted. But Kinthar village could not have such an opportunity because of having less access to the natural forest and plantations could not provide fodder for cattle.

In terms of income earning, NTFPs provided 0.94 % and 0.69 % of the average income of Shwesidaing and Kinthar villages respectively. According to the findings, the percentage of household income from NTFPs is very low because of low productive potential and limited varieties of forest products. Nevertheless, remnant natural forests of the dry zone could provide the NTFPs to some extent to the households of both communities but plantation provided none.

People from both villages planted multipurpose trees in their home yards, which contributed tree products as fruits, leaves, and seeds and used these for subsistence consumption. In terms of financial value of these products, Shwesidaing and Kinthar communities earned 6.98 % and 4.03 % of their average income

respectively. Therefore, it is necessary to encourage home garden development not only for household income but also to contribute dry zone greening.

6.2. Financial Analysis

6.2.1. Cost of cultivation and valuation of outputs

Establishing plantations incurs expenses on planting materials and planting, tending operations such as weeding, cleaning and pruning at different stages, maintenance throughout the rotation and final harvest at the rotation age. Intermediate yields are not considered because thinning has not been carried out in the dry zone plantations. Therefore, the final felling only provides financial benefit from 9-year-old *Eucalyptus camaldulensis* plantations. Likewise, it is assumed that standing volume of the remnant natural forest (based on DBH ≥ 5 cm) is considered as final products.

For deriving the financial benefit, the quantity of each item of output is multiplied by the corresponding price. Under this study, pole is defined as the sizes ranging from 5 cm. to 9 cm. In mid-diameter and post has the sizes ranging from 9.1 cm to 28 cm in diameter with no limit in length. Estimated prices of posts and poles and standing volume per hectare of the forests are given in Table 10.

Table (10) Average Estimated Prices of Post and Pole and Standing Volume of the Remnant Natural Forest and 9-year-old *Eucalyptus camaldulensis* Plantation

Type	Product	Standing volume [$m^3.ha^{-1}$]	Price per m^3 [Kyat]	Remarks
Natural forest	Post	3.06	1,389	Assortment of sizes of different species
	Pole	9.43	889	
Plantation	Post	119.45	750	Assortment of sizes
	Pole	5.07	600	

Source: Field survey, 2002

6.2.2. Physical and financial production model of *Eucalyptus camaldulensis* plantation

In dry zone plantations, weeding is carried out in the initial year (year 0) and in the first year (year 1). Climber cutting and soil working are also done simultaneously with weeding operation. Fire protection is carried out up to the age of year four. Two fire lines of 10 m in width are built along the entire length of plantations. Table 11 shows the physical and financial production model for establishment of one hectare of *Eucalyptus camaldulensis* plantation.

Table (11) Physical and Financial Production Model for Establishment of One Hectare of *Eucalyptus camaldulensis* Plantation

Age [year]	**Type of operation**	**Estimated mandays per hectare**	***Cost per hectare [Kyat]**	**Standing volume [m^3. ha^{-1}]**
0	Site preparation (1.8 m x 0.5 m x 0.5 m pit)	25	7,500	-
0	Planting (3.7 m x 3.7 m)	10	3,000	-
0-1	Weeding (three times in the first year)	10	6,000	-
1	Patching (one time in the first year)	5	1,500	-
0-4	Fire protection (10 meter width x 2 lines)	5	7,500	-
0	Inspection path (2 meter width x 3 lines) (in the first year)	3	900	-
0-9	Management (over head costs)	3	9,000	-
9	Felling (manual) (labour costs)	25	7,500	124.52

Source: The author analysis, 2002

* Labour costs

The financial analysis was done for the plantation based on the productive capacity of the Dry Zone region. At the age of nine years, the standing volume of *Eucalyptus camaldulensis* plantations is 124,52 m^3 per hectare. Intermediate yields are not available because thinning has not been carried out. Using the average costs and returns per hectare, the results of the profitability analysis of *Eucalyptus camaldulensis* plantation are presented. Table 12 shows cash flow of 1 hectare of *Eucalyptus camaldulensis* plantation in the dry zone.

Table (12) Cash Flow of 1 ha of *Eucalyptus camaldulensis* Plantation in the Dry Zone

Age [year]	**Type of operation**	**Cost per ha [Kyat]**	**Benefit per ha [Kyat]**	**Cash flow [Kyat]**	**Accumulated Cash flow [Kyat]**
(1)	(2)	(3)	(4)	(5)	(6)
0	Planting	18,300	0	-18,300	-18,300
0-1	weeding, fire protection, inspection path, management cost	5,400	0	-5,400	-23,700
2	fire protection, inspection path, management cost.	2,400	0	-2,400	-26,100
3	fire protection, inspection path, management cost	2,400	0	-2,400	-28,500
4	fire protection, inspection path, management cost	2,400	0	-2,400	-30,900
5	Management cost	900	0	-900	-31,800
6	Management cost	900	0	-900	-32,700
7	Management cost	900	0	-900	-33,600
8	Management cost	900	0	-900	-34,500
9	*Final felling and management cost	8,400	92,630	+84,230	+49,730
	Total	**42,900**	**92,630**		**49,730**

Source: The author analysis, 2002

*Standing volume per hectare is calculated based on all the trees DBH ≥ 5 cm

In plantation, during the initial year, a cost of 18,300 Kyats per hectare is incurred for site preparation, raising nursery, planting, patching, fire protection and management. The total cost (including final felling) of 9-year-old *Eucalyptus camaldulensis* plantation is 42,900 Kyats per hectare. The benefit of final felling yield at the rotation age of 9 years amounts to 92,630 Kyats per hectare and the net benefit (accumulated cash flow) at the end of year 9 are 49,730 Kyats per hectare. Table 13 shows the internal rate of return (IRR) of *Eucalyptus camaldulensis* plantation.

Table (13) The IRR of *Eucalyptus camaldulensis* Plantation

Standing Volume [$m^3.ha^{-1}$]	Discount Rate						IRR [%]
124.65	5%		10%		15%		12.46
	NPV	BCR	NPV	BCR	NPV	BCR	
	22,002	1.58	5,138	1.15	-5,286	0.83	

Source: The author analysis, 2002

Concerning the IRR criterion, the plantation provides 12.46 percent, which is also the maximum interest rate (break even point). On the other hand, at the break even point the project could earn back all the capital and operating costs expended on it, and pay 12.46 percent for the use of money in the meantime. Using a discount rate of 8 percent, *Eucalyptus camaldulensis* plantation generates the NPV of 10,918 Kyats per hectare. It means that *Eucalyptus camaldulensis* plantation is acceptable at that discount rate from a pure financial point of view.

6.2.3. Physical and financial production model of conservation of natural forest

In the Dry Zone, degraded forests, which have been considered to be capable of improving naturally, are identified, demarcated and protected. Cultural operations such as climber cutting, pruning and cleaning are provided, where necessary in order to accelerate natural growth. These treatments are carried out only in the initial year. Fire protection is done up to the age of four years. Table 14 shows the physical and financial production model for conservation of one hectare of the natural forest.

Table (14) Physical and Financial Production Model for Conservation of One Hectare of the Natural Forest

Age [year]	Type of operation	Estimated mandays per hectare	*Cost per hectare [Kyat]	Standing volume [$m^3.ha^{-1}$]
0	Boundary demarcation	3	900	-
0	Cultural operations	4	1,200	-
0-3	Fire protection (10 meter width x 2 lines)	3	3,600	-
0-9	Management (over head costs)	1	3,000	-
9	Felling (manual) (labour costs)	5	1,500	12.49

Source: The author analysis, 2002
* Labour costs

During the conservation period of nine years, the forest is estimated to attain a standing volume of 12.49 m^3 per hectare. Based on the return per hectare (standing volume per hectare), the cashflow is given in Table 15. It can be observed that the return exceeds the costs at the end of 9 years conservation period even though productive potential of dry forest is very low.

Table (15) Cashflow of Conservation of the Natural Forest in the Dry Zone (based on 1 ha)

Age [Year]	Type of operation	Cost per ha [Kyat]	Benefit per ha [Kyat]	Cash Flow [Kyat]	Accumulated cash flow [Kyat]
(1)	(2)	(3)	(4)	(5)	(6)
0.	Conservation activities (a) field surveying (b)boundarydemarcation (c) cultural operations (d) fire protection (e) management cost	3,300	0	-3,300	-3,300
1.	Fire protection and management	1,200	0	-1,200	-4,500
2.	Fire protection and management cost	1,200	0	-1,200	-5,700
3.	Fire protection and management cost	1,200	0	-1,200	-6,900
4.	Management cost	300	0	-300	-7,200
5.	Management cost	300	0	-300	-7,500
6.	Management cost	300	0	-300	-7,800
7.	Management cost	300	0	-300	-8,100
8.	Management cost	300	0	-300	-8,400
9.	*Final felling and management cost	1,800	12,633	10,833	+2,433
	Total	**10,200**	**12,633**		**2,433**

Source: The author analysis, 2002

*Standing volume per ha is calculated based on all trees DBH ≥ 5 cm

In the Dry Zone natural forest, during the initial year, a cost of 3,300 Kyats per hectare is incurred for conservation activities, such as, field surveying, boundary demarcation, cultural operations, fire protection and management. The total cost at the end of the year 9 is 10,200 Kyats per hectare including final felling costs. The income from final yield at age of 9 years amounts to 12,633 Kyats per hectare and

the net benefit (accumulated cash flow) at the end of 9 years is 2,433 Kyats per hectare. Table 16 shows the internal rate of return (IRR) of the natural forest.

Table (16) The IRR of the Remnant Natural Forest

Yield [$m^3.ha^{-1}$]	Discount Rate								IRR [%]
12.49	1%		2%		3%		4%		3.63
	NPV	BCR	NPV	BCR	NPV	BCR	NPV	BCR	
	1,663	1.17	971	1.10	351	1.04	-206	0.98	

Source: The author analysis, 2002

The slow growth of the natural forest results in the IRR of only 3.63 percent. It means that the maximum interest rate that the project could pay for resources used is only 3.63 percent. Using a discount rate of 8 percent, the NPV of conservation of natural forest shows negative sign (negative NPV). It means that conservation of remnant natural forest is financially not acceptable at that discount rate.

6.2.4. Sensitivity analysis

The objective of sensitivity analysis is to see how changes in costs and benefits are affecting the profitability of conservation of natural forest and plantation establishment. The economic analysis of project is based on uncertain future events and inaccurate data, and therefore inevitably involves probability judgements, whether made explicit or not. In this sensitivity analysis, the reactions of NPVs and IRRs to the following changes are examined:

(1) increasing labour costs by 10 %;
(2) charging the annual land tax;
(3) decreasing the prices of products by 10 % and
(4) reducing the standing volume by10 %.

Table 17 shows a comparison between the reactions of NPVs and IRRs of forests while input and output variables are changed (at 8 percent discount rate in both cases).

Table (17) Comparison between the Reactions of NPVs and IRRs of Forests while Input and Output Variables are Changed

Sensitivity analysis by:	Plantation Forest		Natural Forest	
	NPV	IRR [%]	NPV	IRR [%]
*increasing 10 % labour costs	3,834	10.85	**Negative**	2.02
charging land tax of 494 Kyats per ha	7,338	10.91	Not calculated	Not calculated
reducing 10 % of prices of forest products	6,284	10.66	**Negative**	1.86
reducing 20 % of standing volume	1,651	8.94	Not calculated	Not calculated

Source: The author analysis, 2002
***** see labour costs in Table 9 and 12.

According to the results presented in Table 17, the profitability of *Eucalyptus camaldulensis* plantation is not significantly changed whereas that of natural forest is sensitive when input and output variables are changed.

6.3. Overall Evaluation on Conservation of Remnant Natural Forest and Plantation Forest

Concerning the contributions of forests in terms of non-timber forest products, the results of this study indicated that conservation of remnant natural forest provided more benefits (i.e. NTFPs) than plantation to the local people (see tables 3 to 8). The majority of the people from both villages collected NTFPs only from the natural forest for subsistence use. People from Shwesidaing village consumed NTFPs more than those from Kinthar community because of the proximity of the forest to the village.

Plantation could not provide NTFPs to the local people at all. People from Kinthar village, had to buy some of these products such as fuelwood, building materials, agricultural implements, fodder, etc. from the market even for subsistence use. Long distance between the forest and village and restricted accessibility are the limiting factors for Kinthar community in obtaining ample non-timber forest products.

In the Dry Zone, although plantations have been established with the main purposes of supplying local needs and environmental restoration, they are also acceptable from financial point of view. According to the results of benefit cost analysis (see Table 13), *Eucalyptus camaldulensis* plantation produces an IRR of 12.46 percent. Using a guiding rate of return of 8 percent, plantation provides a NPV of 10,918 Kyats per hectare. It is of crucial importance for development of plantation

forestry but productive potential of plantations has to be taken into account for a long term.

However, conservation of natural forest is not feasible from a pure financial point of view (see Table 16). The returns (yield per hectare per year) from conservation of natural forest are quite low because of slow growth rate of indigenous tree species. The IRR of conservation of natural forest is 3.63 percent. Using a guiding rate of return of 8 percent, conservation of natural forest generates negative NPV. In this case, it is necessary to take into consideration the ecological and social benefits (i.e. tangible and intangible benefits) of conservation of remnant natural forests for a long term.

In addition, non-market benefits of forests were considered as one of the priority objectives because non-economically manifested values such as recreational, spiritual and religious value are considerably important for the society. Although such values are difficult to measure, they are recognized in valuing the contributions of forests to the human welfare. In relation to non-market benefits of the forest, the perspectives of the people from different strata of society are given in Table 18.

Table (18) Perspectives of the People on Two Rehabilitation Techniques in Relation to Non-market Benefits of the Forest

Non-market benefits	Total no. of respondents	Natural forest		Plantation forest	
		No. of respondents	Percentage	No. of Respondents	Percentage
Recreational value	75	63	84	7	9
Aesthetic value	75	52	69	18	24
Soil erosion control	75	50	67	20	27
Water retention capacity	75	59	79	11	15
Spiritual and religious value	75	60	80	10	13

Source: Field data, 2002

Table 18 indicates that majority of people from different strata of the society prefer natural forest to plantations. Most of the people prefer natural forests for recreational and aesthetic values. People said that they liked natural forest because of its structure, composition of different species and different age classes. Majority of people also recognised that natural forest could control soil erosion, and retain water more than plantation. In this case, people replied that natural forests have dense ground cover vegetation whereas dry zone plantation has none.

In relation to spiritual value of forests, most of the people traditionally believed that natural forests possessed more spiritual value than plantations. People prefer the naturally regenerating forests for their unique spiritual values to the man-made and often targets-oriented plantations.

According to the results of overall evaluation on conservation of natural forest and plantation establishment, it is not possible to select the best suitable rehabilitation technique definitely for the dry zone regreening. The best possible way is to define the specific objectives of dry zone plantations and selection should be done based on these set objectives. In doing so, it is necessary to balance between financial, social and ecological effects of rehabilitation measures as much as possible.

7. CONCLUSION AND RECOMMENDATIONS

Based on the results of the study, the following conclusions and recommendations are drawn for the successful implementation of the dry zone rehabilitation program.

- From a social standpoint, most of the rural community in the dry zone depend on natural forests for their household needs. Therefore, remnant natural forest need to be conserved wherever feasible for social and ecological purposes. There is a need to protect and judiciously utilise locally valuable tree species such as *Xylia dolabrifromis, Shorea oblongifolia Pentacme siamensis, and Dalbergia oliveri*. This should be accompanied by appropriate silvicultural treatments.

- Forests cannot be conserved unless people are fed well enough. It is, therefore, vital to target rehabilitation projects towards meeting basic needs of the local people in addition to environmental rehabilitation and long-term profit maximisation.

- The fuelwood crisis in the dry zone as well as in other similar areas should be tackled at the national level as it is the root of all economic, social and environmental ills of the country. It can be solved only if there is a definite fuelwood policy in line with privatisation. Based on this concept, the Forest Department should promote Community Forestry Instructions (CFI) and encourage the formation of village, communities or private groups to manage, control and utilise fuelwood from reserved forests, unclassified forests or lease the lands to these communities for tree/fuelwood production purposes.

- From ecological point of view, plantation forest is not sustainable in the long run and it may promote localised ecological deterioration. Therefore, plantation should be established only in the bare lands and in places, where natural regeneration of indigenous species is not possible or insufficient for adequate restocking. Complete clearing of land for plantation should not be encouraged.

- Uncontrolled grazing of excessive number of livestock herd for extended period of time leads to the destabilisation of the naturally sensitive dry forest ecosystem. It is thus appropriate to carefully plan sustainable forest grazing and to demarcate appropriate grazing areas for the local communities. This would ultimately enhance sustainable utilisation of the natural resource bases. Fodder tree species such as *Leucaena leucocephala, Albizzia lebbek, Azadirachta indica, Acacia catechu* etc. need to be introduced and used as an integral part of dry zone plantations.

- From financial point of view, plantation is quite appropriate for the dry zone. However, the number of species which is suitable for the dry zone ecology is very limited. Moreover, long term productivity and adverse environmental impacts of plantations have to be taken into account.

- Lack of specific objectives and comprehensive management plan of plantations may lead to failure of dry zone rehabilitation project in achieving their goals. Therefore, it is imperative to carefully define and precisely tune objective of plantations. Once set, the objectives have to be implemented. In addition, the implementing organisations should keep their commitments to the local communities to achieve people's participation.

The study draws the conclusion that 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. Therefore, it should be established only in places, where there is no vegetation cover or very thin or sparse vegetation cover. From social point of view, natural forest can fulfil the basic needs of the local people more than plantation. It is also ecologically sound. Therefore, social and ecological targets-oriented conservation of natural forest should be carried out wherever possible in the dry zone of Myanmar.

Annex 1

Questionnaire for the village people

Basic Data

Township
Village
No of households
Name of respondent
Educational level
No. of household member

Availability of NTFPs

1. What is the type of fuel do you use? How much percentage?
   Firewood
   Charcoal
   Animals dung
   Briquettes
   Agriculture residue
2. How much percentage of fuelwood did you collect from the following sources?
   Natural forest
   Plantation
   Home garden
   Farm
   Market
   Others (specify)
3. How many bundles of firewood did you use monthly?

No. of bundles	Market price per bundle	Total cost per month

4. If you used charcoal, how many sacks of charcoal did you use monthly?

No. of sack	Market price per sack	Total cost per month

Building Materials and Agricultural Implement

5. Did you collect wood for household construction? (pole, post, bamboo, thatch and fencing materials)
   Yes
   No

6. If yes, from where did you collect building materials?
   Natural Forest
   Plantation
   Home Garden
   Farm
   Market
   Others

7. Which items did you collect for household use and how many of each item did you consume per year?

Category	Unit	Quantities	Market price/unit	Total Cost
Post				
Pole				
Thatch				
Fencing				
bamboo				

8. Did you collect wood for agricultural implement?
   Yes
   No

9. If yes, which kind of agricultural implement was available from collected wood and how many of each item did you consume per year?

Category	Unit	Quantities	Market price/unit	Total cost

Fodder and grazing

10. Do you have domestic animals (Livestock)?
    Yes
    No

11. If yes, what types and number do you have?

No.	Type	Quantity

12. Did you collect fodder for your livestock?
    Yes
    No

13. If yes, how many bundles of fodder did you need per day?

14. From where did you collect fodder for your livestock?
    Natural Forest
    Plantation
    Farm
    Home garden
    Market
    Others
15. Did you graze your livestock?
    Yes
    No

16. If yes, where did you graze?
    Natural Forest
    Plantation
    Common grazing land
    Others (specify)

Medicinal Plants

17. Did you collect medicinal plants (materials)?
    Yes
    No

18. If yes, from where did you collect medicinal plants?
    Natural Forest
    Plantation
    Cultivation
    Others (specify)

19. How often did you collect medicinal plants?

Bush meat

20. Did you practise for bush meat?
    Yes
    No

21. If yes, where do you prefer for hunting?
Natural forest
Plantation

22. If yes, how many kilograms (kg) of bush meat did you get per month?

Category	Unit	Price/unit	Quantities
Bush meat			

23. How did you use collected NTFPs?
Subsistence
Market

24. Could you please tell me your opinions on non-market benefits of natural forest and plantation forest? How do you think that which one is better for the following benefits? (for different strata of society).

Non-market benefits	**Natural forest**	**Plantation forest**
Recreational value		
Aesthetic value		
Soil erosion control		
Water retention capacity		
Spiritual and religious value		

Annex 2

Average market prices of fuelwood, fodder, building materials and agricultural implements in the study area

No.	Categories	Unit	Market price/unit (Kyat)
1.	Post	No. (00)	900
2.	Pole	No. (00)	250
3.	Fuelwood	Bundle	50
4.	Thatch	No. (00)	20
5.	Fencing materials	Cartload	500
6.	Shaft of harrow	No. (00)	125
7.	Harrow´s timber	No. (00)	800
8.	Harrow´s tooth	No. (00)	5
9.	Stock of a plough	No. (00)	800
10.	Plough beam	No. (00)	200
11.	Yoke (Bullock cart)	No. (00)	1000
12.	Bamboo	No. (00)	20
13.	Fodder	Bundle	70
14.	Bush meat	Kg	500

8. REFERENCES

(1) Barraclough, S.L. and Ghimire, K.B. (1995). Forests and Livelihood. Great Braintain.

(2) Bryman, A. (1995). Quality and Quantitiy in Social Research. U.K.

(3) Evans, J. (1982). Plantation Forestry in the Tropics. Second edition, Oxford University Press – Great Britain.

(4) F.A.O paper 9 (1991). Socio-economics Attributes of Trees and Trees Planting Practices. Rome.

(5) F.A.O (2001). The Global Forest Resources Assessment. Rome.

(6) Flaconer, J. and Arnold, J.E.M (1991). Household Food Security and Forestry; An Analysis of Socio-economic Issues. Rome.

(7) Gittinger, J. P. (1982). Econonics Analysis of Agricultural Projects. Second edition. The Johns Hopkins University Press – Washington, D.C.

(8) Gregersen, H. and Contreras, A. (1992). Economics Assessment of Forestry Projects. F.A.O. Rome.

(9) Kyaw Htun, U (1999). Notes on Financial and Economics Analysis. Forest Department – Yangon.

(10) Lamprecht, H. (1989). Silviculture in the Tropics. GTZ – Eschborn 1. Germany.

(11) Luna, R. K. (1989). Plantation Forestry in India. Dehra-Dun, India.

(12) Mishra, N. K. (1997): Social Forestry in India- A Study of Economic Aspects. India

(13) Neuman, W.L. (2000). Social Research Method: Qualitative and Quantitative Approaches. Allyn and Bacon. USA.

(14) Schtzman, L. and Strauss, A. (1973). Field Research: Strategies for Natural Sociology. Englewood Cliffs, Nj: Prentice – Hall.

(15) Soe Myint (1995). Dry Zone Greenging Project- Zonal Report 1. Yangon.

(16) Thaung Naing Oo (2002). Comparative Study on Socio-economic Impacts of Dry Zone Rehabilitation Techniques; A Case Study of Two Villages in Mandalay Division, Myanmar. M.Sc. Thesis. Dresden Technical University- Germany.

(17) Yin, R.K. (1989). Case Study Research, Design and Methods. California.