Cost-Benefit Analysis of "Rainforestation Farming" in Leyte Island, Philippines

Project Thesis
in the frame of the Master course "Tropical and International Forestry",
Faculty of Forestry and Forest Ecology, Georg-August-University Göttingen

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“Unless we properly manage resources like forests, water, land, minerals and oil, we will not win the fight against poverty. And there will not be peace.”

Wangari Maathai, Nobel Peace Prize Award 2004

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Abbreviations

AN:	**Annuity**
CBA:	**Cost-Benefit Analysis**
CBFM:	**Community Based Forest Management**
CBR:	**Cost-Benefit Ratio**
CDM:	**Clean Development Mechanism**
CER:	**Certified Emission Reduction**
CSC:	**Certificate of Stewardship Contract**
DBH:	**Diameter at Breast Height**
DENR:	**Department of Environment and Natural Resources**
IPR:	**Individual Property Rights**
IRR:	**Internal Rate of Return**
ITE:	**Institute of Tropical Ecology**
ITPR:	**Individual Time Preference Rate**
KfW:	**Kreditanstalt für Wiederaufbau**
LGU:	**Local Government Unit**
LSU:	**Leyte State University**
MOA:	**Memorandum of Agreement**
NPV:	**Net Present Value**
OCR:	**Opportunity Cost Rate**
PhP:	**Phil. Peso**
PV:	**Present Value**
RF:	**Rainforestation Farming**
tCER:	**Temporary Certified Emission Reduction**
TIF:	**“Tropical and International Forestry” Mastercourse at Goettingen Univ.**

Preface

This on hand Cost-Benefit Analysis about “Rainforestation Farming” (RF) was conducted in the frame of the lecture “Development of a forest region outside Germany” of the Master-course “Tropical and International Forestry“(TIF), Faculty of Forestry and Forest Ecology, University Göttingen. The project started in October 2004 with planning and literature research in Göttingen. From 23.11.2004 – 17.12.2004 the course students took part in a one month excursion to Leyte, Philippines. The overall goal of this excursion, that was led by Prof. Dr. *Edzo Veldkamp*, Prof. Dr. *Dirk Hölscher*, Dr. *Roland Olschewski* and *Mathias Petri*, was to conduct further research about “Rainforestation Farming”, in order to write this Cost-Benefit Analysis. Last years Cost-Benefit Analysis declared this type of land-use system as very advantageous in economic and ecological concerns. Because RF is a relatively new afforestation scheme, economic aspects are based on assumptions (Dirksmeyer 2000) and not on empirical data. To create an empirical data pool as basis for an economic analysis, interviews and different kinds of field work (forest inventory, light intensity measurements and soil inventory) were applied during the stay.

Acknowledgements

Being guests of our partner university - the Leyte State University (LSU) - near Baybay, we not only benefited from comfortable accommodation and other facilities but also experienced a warm hospitality and excellent professional advice and support. Therefore, we would like to thank Dr. P.P. *Milan*, president of the LSU for welcoming us and supporting our work at the LSU. The entire staff of the “Institute of Tropical Ecology”, lead by Dr. *M. J. C. Ceniza* and the staff of the “Forestry College“, led by Dr. *Ed Mangaoang*, deserve special thanks as they not only supported our work in a professional kind but also arranged our stay in a very convenient and enjoyable manner. Most of the work had been impossible without the help of our Philippine counterparts, *Joseph L. Maceda*, *Inan Hernando Mondal* and *Darwin Posas*: They were a great help in translating and during the field work.

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Göttingen, June 2005 *Master students of Tropical and International Forestry*

Summary

This on hand Cost-Benefit Analysis compares the costs and benefits of two different agroforestry systems in Leyte Island, Philippines. It focuses on the question whether Rainforestation Farming (Afforestation with indigenous tree species, intercrops and fruit trees) is more profitable than *Acacia mangium* / Abaca plantations. Since deforestation and resulting soil erosion and rural poverty are the severe problems in Leyte, it is essential to determine the most beneficial land use in terms of economic and ecological impacts. As fertility of soils and productivity of Coco plantations are decreasing while the price of the main product copra is also caving in, a change of land use is urgently required to stop further impoverishment of the population and to stop the negative impacts of deforestation.

Both considered alternatives are regarded as being able to overcome these problems. Eleven Rainforestation (RF) sites were analysed in details (soil inventory, forest inventory, economic analysis, and possible constraints). The overall result of this analysis is that eight sites will probably achieve a higher net welfare gain than *Acacia/Abaca* plantations even if considered conditions will decrease to a certain amount. Seven out of eleven sites even achieved a higher Net Present Value (NPV) than the supposed optimistic RF projection of Dirksmeyer (2000). Only one site produced a negative NPV as most of the area burned down during a forest fire. Furthermore, payments for carbon sequestration were integrated in the analysis. These possible payments would generate a relative high benefit increase for sites that do not achieve high NPVs and could serve as further incentive to establish RF sites on poor soils.

Basing on the applied projections and forecasts, most of the RF sites will achieve a high NPV. Highest net revenues are achieved by those sites that do not only rely on income from timber but enforce the production of non timber products such as intercrops, fruits and rattan. From an economic point of view, these products are interesting as most of them produce rapid income after the initial investment. Besides these entire positive findings one has to keep in mind that the data base is still relatively weak and that most farmers require extension services to improve timber stand quality and non-wood products yield as most analysed stands appeared to be very dense and would require thinning operations. Moreover, it is strongly advisable to overcome the juridical constraints in the Philippines that so far hamper harvesting of timber.

1. Introduction

The Philippines is inhabited by 81,5 million people and annual population growth stands at a level of 1,9 % to 2,3 % (1999-2003) (World Bank Group 2004). While the population is still growing, poverty in the Philippines worsened from 1985 to 2000 (ADB 2004a). Rural poverty is much more pronounced than urban poverty and resulting exploitation of natural resources (mainly forest lands and marine ecosystems) is threatening the foundation of the livelihood of the rural population (ADB 2004a).

Besides poverty, deforestation and its consequences is of major concern in the Philippines (ADB 2004a). While pristine and species rich Dipterocarp dominated rainforests covered almost 70 % of the total area by the end of the 18^{th} century (Schulte 2002), only 13 % of the total land area was still covered with forest in 1997 (DENR 2003). Out of this forest area, less than 3 % consists of old growth *Dipterocarpaceae* forest while most forest cover is formed by residual, secondary forests and plantations (DENR 2003). This enormous loss of forest area can be traced back to intensive logging activities in the decades after the Second World War and to slash-and-burn practices that were enhanced by migration due to impoverishment and fast population growth (Dirksmeyer 2000). More than 10 million m^3 of wood were exploited per year and resulted in annual forest clearings of 300.000 ha, due to conversion of logged-over forest to agricultural use (Schulte 2002).

Leyte island, situated at 10° northern latitude and 125° eastern longitude (Langenberger 2000), belongs to the Visayan Island group (Region VIII) in the Philippine Archipelago and covers roughly 0, 8 million ha. Leyte comprises “Leyte province” (~0,57 million ha) and “Southern Leyte province” (~0,23 milion ha). Volcanic activities uplifted and formed the island’s steep and rugged central cordillera. Land with a slope of more than 18% is classified as forest land (Dirksmeyer 2000). In the province of Leyte, where the study was conducted, this classification covers 49% of the area. Out of this area, about one third shows slopes between 30 and 50% and 10% of this area are inclined with more than 50 percent (Dirksmeyer 2000). Most soils belong to the group of *Orthic Acrisols*, *Dystric Nitrosols*, *Glyic Cambisols*, *Glysols* and *Pellic Vertisols* (Goelthenboth & Goelthenboth 2000). The climate is tropical with an average temperature of 26-27°C and a mean annual precipitation of 2700mm (Goelthenboth & Goelthenboth 2000).

The population of the province of Leyte as of September 1995, is 1,511,251. This leads to a population density of 265 persons per square kilometre (National Statistics Office 1995). Considering that settlement within the forestland, even though it is not completely forested, is illegal (Dirksmeyer 2000), population density would theoretically even double within the coastal area. Whilst most of the population is concentrated in the coastal plain, illegal settlement does exist in a big scale (Dirksmeyer 2000). The average household size in Leyte is 5 persons and population growth is with 1,51% below the Philippine average (National Statistics Office 2003).

Poverty is widespread in Leyte: Mean annual income is 93,251 PhP (NEDA 2000b) and the poverty incidence of families stands at 36,1% (NEDA 2000a). By magnitude, Leyte is the 7^{th} poorest Island in the Philippines (ADB 2004a). Regarding the *Gini*-coefficient of Leyte (0,521) as important poverty indicator, Leyte stays far below the Philippine average of 0,466 (ADB 2004a). Based on numerous selected poverty indicators, Leyte only achieves the 52nd ranking out of the 77 Philippine provinces (National Statistics Office 1999).

About more than half of the households in Leyte depend on income from agriculture and fishing. Agricultural crops are dominated by rice (Oryza sativa), abaca (*Musa textilis*) and copra (*Cocos nucifera*) (Dirksmeyer 2000). Limited access and restricted availability of suitable agricultural land with a slope of less than 18% urges farmers to clear forest lands and to apply the so called "*kaingin*" (shifting cultivation) (Schulte 2002). In addition, "*timber poaching*" (illegal logging) - partly favoured by corruption and a lack of control - takes place on a large scale (Schulte 2002).

The results of these practices in Leyte are as evident as in most islands of the Philippines: Landslides triggered by heavy rainfalls, swept away settlements and killed thousands of people (Ormoc City 1991: more than 5000 casualties; Liloan and Panaon Island 2003: more than 200 deaths) (BBC 2003). Besides these apparent effects, soil erosion and leaching of nutrients lower the fertility of the soils (Dirksmeyer 2000). Water sheds are also exposed to deterioration and coral reefs along the shore are threatened by the resulting off-shore siltation (Margraf & Milan 1996).

Fearing a total loss of the forest area and its severe economic and ecological consequences, the Philippine Government implemented a log ban in 1992. This sanction was accompanied by afforestation initiatives of the forestry sector. In the end of the 1980s, reforestation campaigns lead to an abrupt rise of afforested areas (more than 100000 ha annually over a period of three years). In the 1990s, approximately 35000 ha were afforested annually (DENR 2003). Reforestation efforts were mainly financed by governmental appropriations, private initiatives and loans from multilateral and bilateral development cooperation (DENR 2003).

Having in mind these facts points up the necessity of improving the welfare situation of the population and at the same time restoring forest stands in order to reduce the negative impacts of the severe deforestation. Starting point for activities are the sloping areas, classified as forest lands. De facto, these areas are often stocked with *Cocos nucifera* or dominated by Cogon grass (*Imperata cylindrica*) (Dirksmeyer 2000). Decreasing soil fertility, a low demand of copra on the world market that resulted in a price cave-in and reduced productivity due to the high age of the palms are reducing the economic incentives for investing in coco plantations. Revenues from grass patches are marginal as only limited grazing is applicable (Dirksmeyer 2000).

Hence there is an urgent need to improve agricultural and silvicultural systems. Numerous facts indicate a high potential for improving the ecological and economic situation of the people on Leyte with agroforestry based afforestations-systems.

Comparing the economic feasibility of a variety of “Rainforestation Farming” sites (RF) with an afforestation scheme of exotic *Acacia mangium*, combined with *Musa textilis*, allows differentiating in detail among distinct different agro-silvicultural systems. Furthermore, the analysis of the project RF site might also be interesting as the assumptions from Dirksmeyer can now be proven by empirical data.

2. Methodology of Cost-Benefit Analysis

Cost-Benefit Analysis (CBA) is applied as an instrument for policy advice in order to evaluate public projects from the viewpoint of economic efficiency. Within the frame of public administration, it resembles the investment analysis of a private firm. CBA is applied for financially significant projects that are not steered by price mechanisms but by political decisions. A CBA is used to determine the advantages and disadvantages that result from public measures.

For this purpose, advantages and disadvantages either of a single project are assessed or different projects or different implementations of the same project are ranked according to their properties. To obtain a result, all positive and negative effects of each project are pooled and converted into monetary units to achieve comparability. As result, a single value, the net-benefit, is being calculated for each project. A political recommendation for a project should only be pronounced if its net benefit is positive (Bergen et al. 2002).

2.1 Underlying principles

The instrument's theoretical background is based on principles of the welfare theory: Assuming scarcity of resources, individual households or firms are urged to act efficiently in order to avoid prodigality. Given the situation of total concurrence, this behaviour will lead to an efficient allocation of resources (Hanusch 1994). From the viewpoint of economic efficiency, the described situation would not request any public interference. Public projects that are mainly governed by political decisions usually do not achieve this positive setting because market mechanisms for certain goods -especially for public ones- might fail or markets for those goods do not exist at all. Considering economic scarcity, a CBA hence follows the goal to examine projects for efficiency (Bergen et al. 2002)

Market analysis of a private firm and CBA fulfil the same tasks but are implemented for different scopes. Important differences are a) the manner resources are allocated and b) the method of valuation of project impacts. Private firms base their decisions about resource allocation on market mechanism while public projects are driven by political decisions or commitments. Whilst private firms only utilise market prices to determine project effects, CBA depends on the calculation of shadow prices and opportunity costs (Hanusch 1994).

Project evaluation in developing countries faces particular problems as differentiation between public and private assessment is usually not clearly demarcated. In those cases, a CBA does not only consider projects that provide public goods but comprises economic ventures that are normally included in the private sector.

The two main reasons for this blurred boundary are a) failure of market allocation mechanisms due to monopoly of markets, official price regulatory procedures or extern effects and moreover b) intensive state activity as investor or to provide infrastructure facilities. This second reason gains special importance if organisations conducting development cooperation (e.g.: KfW, Worldbank, etc.) provide grants or loans for investment (Bergen et al. 2002).

Cost-Benefit Analysis is based upon an anthropocentric point of view. Therefore, only those advantages and disadvantages that cause effects by the concerned people are included. Furthermore, CBA utilises *consumers' sovereignty* to determine project impacts. That means that only the consumers` appreciation of the public project is important. Neither political preferences nor expert advices are relevant for the evaluation of the project. Evaluation of costs and benefits is exclusively done by concerned people and not by third parties. In order to measure economic welfare, all individual positive and negative effects are summed up and the net welfare change of a project is being calculated. Thus, measurement of welfare consequences base on an individualistic point of view. Additionally, the *"$=$-principle"* is applied, which implies that the total net-effect is more important than possible negative effects for single persons: If the project is achieving an overall positive net benefit, people benefiting from it could compensate the ones that are "losing" benefits so that finally everyone is achieving a higher total welfare (Bergen et al. 2002).

The scope of a CBA has to be limited both in time and space. The temporal dimension is usually determined by the chosen planning horizon of the concerned project whereas this could be extended to further generations (Hanusch 1994). The geographic dimension is deduced by the range of the project impacts whereupon most CBAs are restricted on a national or even regional level and are seldom applied on an international level (Bergen et al. 2002).

Impacts of an in fact project can be described as the difference between the situation with project and the one without project. Applying this "*With and Without-Principle*", one has to attend that settings tend not to be static but are likely to change over the planning horizon. This counts especially for forestry projects that usually run over a long planning horizon. If changes will not be included in a CBA, effects are likely to be over- or underestimated (Bergen et al. 2002). As a matter of course, only effects that are caused by the project are included in the analysis (Hanusch 1994).

2.2 Structure of Cost-Benefit Analysis

This on hand Cost-Benefit Analysis about afforestations systems in Leyte / Philippines is set up following the structure proposed by Hanusch (1994).

Table 1: Structure of a Cost-Benefit Analysis (CBA); (adapted from Hanusch (1994))

Structure of a Cost-Benefit Analysis (CBA):
1. Definition of relevant constraints
2. Selecting feasible alternatives
3. Determination of project impacts
4. Discounting costs and benefits (temporal homogenisation)
5. Comparing costs and benefits of the selected alternatives
6. Considering risk and uncertainty
7. Final ranking of the alternatives

First, a theoretical explanation and background will be given for each chapter (chapter 2.3 to 2.9) before going into details of the analysed forestry projects in Leyte, Philippines in the chapters 3 to 9.

2.3 Definition of relevant constraints

The choice of different project alternatives is limited by a variety of constraints that reflect the settings of an economy. Hence, certain aspects of projects or projects as a whole can not be realised due to natural restrictions, social or political agreements and laws. These settings are likely to vary in time and from country to country (Hanusch 1994). Relevant constraints were classified and described in general in the following chapters 2.3.1 to 2.3.5 and will be dealt with in detail for the analysed afforestation schemes in chapter 3.

2.3.1 Physical constraints

This term encompasses the central elements of the production function: the natural and technical relation between production factors (labour and capital) and the resulting / produced goods. To overcome a possible shortage of certain production factors (that would result in a lower amount of produced goods) in the domestic economy, missing factors can be imported from abroad (Bergen et al. 2002). In the frame of this CBA, natural settings (e.g.: soil condition, climate, water supply, concurrence with other vegetation, light conditions, etc.) play a major role as they are limiting the growth of tree species and agricultural crops.

2.3.2 Financial constraints

Budget restrictions for public projects are usually determined by the decisions of the responsible political actors. Project alternatives exceeding this budgetary frame can not be included in the CBA. Since the costs of projects can –in most cases- only be determined after having carried out a CBA, exact statements regarding costs of projects can only be given after implementation. If it becomes obvious that a project exceeds the budgetary boundaries but achieves a high net benefit, the political decision maker should concern an extension of the financial resources (Bergen et al. 2002).

2.3.3 Juridical constraints

Planning and implementation of public projects must fulfil the requirements of the valid laws and regulations (property laws, environmental conservation laws, etc.). Projects, violating those constraints, are to be rejected. Should a certain project -that is not in the frame of the juridical frame- achieve a high net benefit, one should communicate the economic loss, due to not realising the project, to the responsible political decision maker (Bergen et al. 2002).

2.3.4 Administrative constraints

Administrative constraints mainly relate to the capacity and capability of relevant authorities (e.g.: supply of information, maps and extension services). A diffuse or very complicated structure of authorities could also aggravate or even hinder project alternatives (Bergen et al. 2002).

2.3.5 Political constraints

Cost benefit analysis examines project alternatives on the background of economic scarcity. Its goal is to determine the alternative with the highest net welfare effect. This goal does not always coincide with all political goals that might include certain minimum requirements of other aspects (gender issues, ecological and strategic aspects or supporting minorities, etc.). If it is obvious, that one or more of those minimum requirements are not met by a certain alternative, this alternative will probably be rejected at first hand (Bergen et al. 2002).

2.4 Selecting feasible alternatives

The quality and sound application of a CBA (and moreover its results that are direct advises for policy makers) strongly depends on the selected alternatives (Hanusch 1994). This CBA only considers forestry projects, being more precise agroforestry projects, as alternatives.

A broad definition of this pristine land use is given by NAIR (in Boehnert 1988):
"Agroforestry is a collective name for land-use-systems and practices where trees and shrubs are deliberately used on the same land management unit with agricultural crops or animals either in some form of spatial arrangements or temporal sequence with both ecological and economical interactions between different components." Following Dirksmeyer, land use in Leyte as of 1992 is divided as follows:

Table 2: Area of land-use types in Leyte

Type of land-use	Area (ha)	Area (%)
Coconut plantation	203,017	35,5
Shrub and Grassland	165,555	29,0
Irrigated rice	84,277	14,8
Forest	59,450	10,4
Other Agriculture	44,754	7,8
Miscellaneous	14,227	2,5
TOTAL	**571,280**	**100,0**

It becomes obvious that only a minor part of Leyte island is used for forests or forest related land-use systems. Forest resources in the Philippines declined rapidly in the last century (see chapter 1. and DENR 2003) and although private and public efforts are undertaken for afforestations projects (DENR 2003), forest resources do not seem to recover or even expand.

Therefore an economic analysis, comparing a combination of an exotic tree species (*Acacia mangium*) and Abaca (*Musa textilis*) with an afforestation scheme that mainly focuses on a variety of indigenous tree species and numerous agricultural crops, might be of high interest. Both alternatives are considered to be effective means to prevent erosion (Otsamo et al. 1996; Schulte 2002). The result might show which alternative is advantageous from the economic point of view, under which conditions these advantages can be achieved.

2.5 Determination of project impacts

The determination of project impacts is the central issue of a Cost-Benefit Analysis. This can be a problematic task as a wide range of effects might be included. First, all positive and negative effects resulting from a specific project have to be gathered. Special consideration is to be drawn to the point that any additional input of a production factor (to achieve higher production) will lead to a withdrawal of production factors of another good and hence reduce the respective production, which might lead to price changes. To overcome this evaluation problem, one can apply the concept of consumers' surplus (see 2.5.1) (Bergen et al. 2002).

In contrast to large scale projects that might have effects on market prices, small scale projects usually do not have any impact on prices. Small projects that only slightly increase the supply of certain goods are unlikely to be responsible for price changes of these goods (e.g.: small afforestations will only supply little timber / lumber in future). It can be assumed that the withdrawal of production factors (from the production of "good 1") and the respective additional production (of "good 2") has no influence on market prices. Hence no change of consumers` surplus can be stated. In these cases, where only quantity changes can be observed, project impacts have to be evaluated by the maximal marginal willingness to pay. The maximal marginal willingness to pay resembles the equilibrium price of the "good 1" and of "good 2" on their respective markets before the project was initiated.

Individual economic units decide on their own –based on their preferences and restrictions- about their demanded amount of goods (*consumers' sovereignty*). By comparing the price with their willingness to pay, they adapt their demanded quantity. Consequently the market price can be seen as a measure of utility and costs (in case of reduced quantities).

Using the concept of consumers` surplus as a measure of utility implies an equivalent transformation of utility units into monetary units. This can only be realised by assuming a constant marginal utility of income. Determining this utility of income requires determination of individual utility changes. As individuals regard utility in different ways, it is an obnoxious task to determine it (Hanusch 1994). Being expressed in ordinal values, utility can not be summed up and does not allow for displaying cardinal differences. In order to overcome these properties of being individual and ordinal, one could choose a constant utility level as a reference (Bergen et al. 2002).

2.5.1 Maximal marginal willingness to pay and consumers' surplus

Figure 1 shows the effects of a project that was initiated to enhance production of X_2. This example assumes that production factors have to be withdrawn from the production of good X_1.

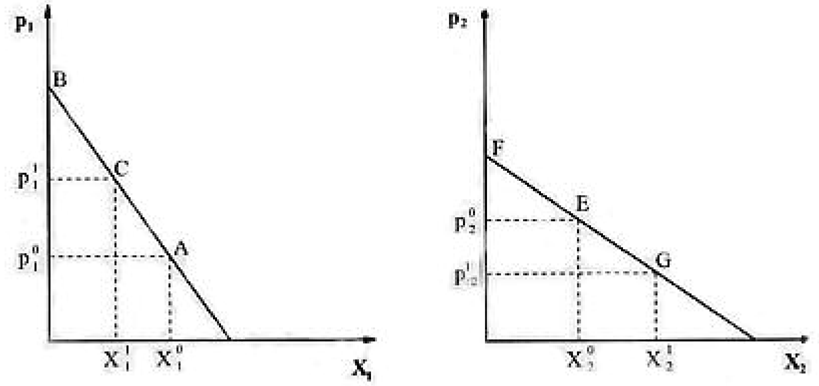

Figure 1: Maximal marginal willingness to pay and consumers` surplus (Bergen et al. 2002)

This withdrawal reduces the supply of X_1 and elevates the price for X_1 from p_1^0 to p_1^1 (see left graph of Fig.1). On the graph on the right hand side, we see rising supply of X_2 (due to the additional production). At the same time, the price for X_2 drops from p_2^0 to p_2^1. In order to evaluate this new situation from the viewpoint of the consumer, one uses the concept of consumers` surplus (Difference between willingness to pay and payment obligation): Regarding the initial setting without project, the consumers` surplus can be displayed by the area p_1^0AB for X_1 and for X_2 by the area p_2^0EF. After implementation of the project the consumers` surplus increased for $X_2$ by the area $p_2^1$GE $p_2^0$ and decreased for $X_1$ by $p_1^0ACp_1^1$. In this case, the increase of consumers` surplus for X_2 is larger than the decrease of consumers` surplus for $X_1$; hence the overall net benefit of the project is positive, because the sum of consumers` surplus of all individuals is larger than the partial loss for X_1 (Bergen et al. 2002).

This example also allows for determination of project impacts by using the concept of marginal willingness to pay: The project causes a quantitative reduction of X_1 from X_1^0 to X_1^1. Maximal willingness to pay for this amount used to be the area $X_1^0ACX_1^1$. This specific amount can be regarded as loss of benefits. On the other hand, lot size of X_2 increases (by additional production that is supplied by the project) from X_2^0 to X_2^1. Maximal willingness to pay for this extra amount of X_2 is the area bordered by $X_2^0EGX_2^1$. If the willingness to pay of all individuals for the additional amount of X_2 exceeds the loss of benefits by reducing the amount of X_1, then the project can be regarded as economically beneficial.

2.5.2 Market price

Producers of goods can be assumed to act in profit maximizing way. By comparing marginal product price and cost for production they adjust their amount of supply. Horizontal aggregation of all supply (e.g.: supply of one similar good by a number of producers) leads to a singular supply curve on the market.

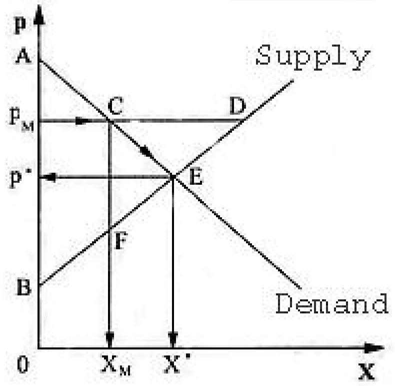

Figure 2: Market equilibrium (Bergen et al. 2002)

Both, demand and supply curve express price /quantity relations. The steering variable is the price. The market is in equilibrium, if demand and supply curve meet each other (Point E in Fig.2). At this point, supply and demand are quantitative equal and buyers accept to pay price p* for the amount X*, vice versa producers agree to sell the amount X* for price p*. Agreeing voluntarily on the market price p* guides both parties –vendor and consumer- in the favourable position of gaining maximum advantages of the trade. For projects that reduce quantity of goods, the market price p* can be employed to determine deriving costs (due to that reduction). For the case of subsistence economy that is relatively common in development countries (e.g.: small scale subsistence farming), there is no need to differentiate between self consumed and sold goods, because the first could achieve the same price p* if being sold on a market (Bergen et al. 2002).

2.5.3 Project effects through factor withdrawal and provision

Whenever production factors are partially or completely withdrawn from (or added to) preliminary stages of the production, problems in the monetary evaluation on the revenue and the cost side appear as these factors can not be assessed correctly. This reduced/additional production will be valuated by the consumer: In most cases, it is extremely difficult to track back withdrawal or provision to the consumer. Hence, one utilises the price of the withdrawn/provided factor for monetary evaluation. The factor price is an expression for opportunity costs for production factors that are not traded on markets. To explain this setting in detail, we have to take a look at how profit-maximizing firms act on factor markets when using their profit maximizing condition:

$$\text{Factor price} \quad = \quad \text{marginal product in terms of value}$$

$$q \quad = \quad p^* \ \delta X_1/\delta V$$

The factor price on the left hand side equals the marginal product in value terms, determined by multiplying the product price p by the marginal productivity (right hand side of equation). The marginal productivity $\delta X_1/\delta V$ reveals the quantitative change of production of good X_1, if the input of V is increased by one unit. By multiplying the marginal productivity with the product price p, one obtains the marginal product in terms of value (Bergen et al. 2002).

Reducing the production factor V by one unit will result in a reduction of the produced good X_1. The influence of the consumer within this calculation is given by the product price p: This is the market price that consumers are willing to pay for this amount of X_1. If the production factor V (that is directly needed for the production of X_1) is remunerated according to the profit maximizing conditions (see Equation 1), the price q constitutes the opportunity costs that derive from the withdrawal of production factors. Thus, the marginal product in terms of value of a factor is of great importance to determine the factors` opportunity costs (Bergen et al. 2002).

2.5.4 Production factor labour

The production factor labour has to be evaluated by using opportunity costs. Usually this is determined by multiplying the amount of working hours with the hourly wage. This procedure can only be applied if labour is needed that was formerly employed in another production scheme [and where labour was paid according to the profit maximising condition (see 2.5.3)]. If the project employs former unemployed workers, the determination of opportunity costs requires considering the marginal product in terms of value: Assuming that unemployed workers are not participating in the production process leads to the result that their contribution to this process is zero and opportunity costs of employing them in a public project are rather low.

2.5.5 Production factor capital

The factor capital includes production factors that will not be dissipated completely during the project period (example: a chainsaw might last longer than the project itself, fences might outlast longer as the project duration etc.). Since capital is bound to these machines or long lasting facilities during the projects` lifetime, this capital can not be utilised for other purposes. As this capital could generate further income if being utilised for other means, this foregone income has to be included by multiplying the capital with the interest rate (see 2.6).

2.5.6 External effects

If economic actions of any economic unit (e.g.: firm, individual farmer, etc.) influence the economic activity of another one, without being reflected by the market mechanism, external effects arise. Public projects can either lead to positive or negative external effects. For a Cost- Benefit Analysis, the extra costs / benefits have to be considered, quantified and included in the analysis from the viewpoint of the concerned individuals (Bergen et al. 2002).

2.5.7 Public goods

Public goods are defined with the attributes "*non excludability of utilisation*" and "*no rivalry of consuming*". Due to these properties, there is usually no market for public goods and hence no market price. Consequently, there is no market price to be used for evaluation purposes. In order to determine benefits derived by public goods, various direct and indirect evaluation methods can be applied (like Contingent Valuation Method, Choice Experiments, Travel Cost Method, Alternative Cost Method, etc. (see also Olschewski 2004).

2.5.8 Foreign exchange effects

Foreign exchange effects have to be taken into account if production factors of the project need to be imported from abroad or goods that are produced will be exported. Imports would lead to further expenditure of foreign currency and exports of goods would cause foreign currency earnings. In both cases, foreign exchange effects have to be calculated in domestic currency.

Coming upon flexible exchange rates, the effects can directly be calculated with the actual exchange rate. When using fixed exchange rates –that are often found in developing countries - one has to consider that applying these exchange rates is likely to overestimate the value of the domestic currency. This is critical, especially if an import (e.g.: machine) is needed: Using the fixed rate, one underestimates the costs. Considering projects that produce export goods on the other hand, implies the tendency to underestimate the revenues on the benefit side. To determine the exchange rate in a correct manner, a higher shadow exchange rate has to be used. In doing so, costs for projects that rely on foreign imports rise and revenues of projects that produce export goods increase (Bergen et al. 2002).

2.5.9 Determination of costs and benefits

The gathering and determination of costs and benefits of the chosen alternatives is the main task of any CBA. Cost and benefits will later on be discounted with the chosen discount rate (see 2.6). Cash flow tables were being calculated with *Microsoft Excel spreadsheets* and all figures are given in Philippine Pesos (PhP).

2.6 Discounting costs and benefits

As long as costs and benefits of a project do occur in the same temporal period, costs and benefits can be summed up and be compared. Considering long term forestry projects, where costs and benefits usually occur at different time periods, costs and benefits have to be weighted by a temporal adjustment, in order to achieve comparability (Hanusch 1994). This weighting is executed by discounting the advantages and disadvantages that appear in following periods back to one basis period, usually the starting period.

Applying fiscal-mathematical formulas, one calculates the present value (PV). By discounting, costs (C) and benefits (B) that occur in later periods are attributed with lower values than costs and benefits that occur in nearer periods:

$$PV(C) = C_0 + C_1/(1+d) + C_2/(1+d)^2 + \ldots + C_T/(1+d)^T = \sum_{t=0}^{T} C_t/(1+d)^t$$

$$PV(B) = B_0 + B_1/(1+d) + B_2/(1+d)^2 + \ldots + B_T/(1+d)^T = \sum_{t=0}^{T} B_t/(1+d)^t$$

Time periods are labelled with t=1,2,3,…t with t=0 as the basis period. Applied discount rate is termed d. Estimation of the present value corresponds to the procedure used for dynamic investment calculations (Bergen et al. 2002). The following parts describe different approaches to determine the discount rate.

2.6.1 Individual time preference rate

Individuals tend to have a positive time preference because the future is uncertain. Applying the individual time preference rate (ITPR) corresponds to the so far applied consumers' sovereignty of the CBA. Gaining information about the level of the ITPR, requires data about the behaviour of households on capital markets. It will become evident, at which interest rate households are willing to save money and at which they are willing to raise a credit. An ideal market would bring out one single interest rate that could be used as discount rate. Since this ideal setting does not exist (interest rates are different for loans and savings), one faces again the problem of choosing one certain interest rate (Bergen et al. 2002).

2.6.2 Opportunity cost rate

This attempt concentrates on the possibilities to increase future consumption by surrender of current consumption.

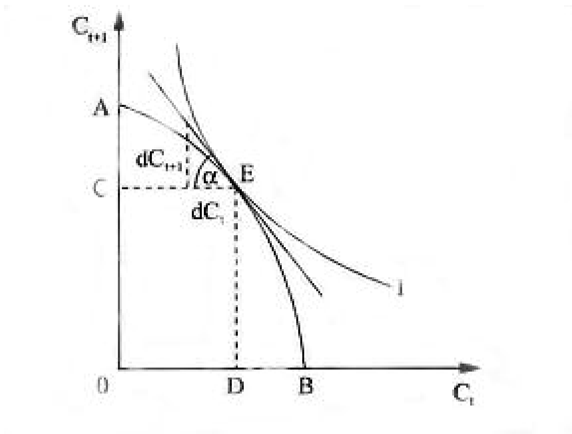

Figure 3: Current and future consumption (Bergen et al. 2002)

Figure 3 illustrates this approach by displaying the current consumption C_t on the x-coordinates and future consumption C_{t+1} on the y-coordinates. All combinations of possible consumption at present and in future are denoted by the transformation curve AB. If OD is consumed today, DB remains as saving and is used for investments, which allows for future consumption 0C. With this possible decision, point E on the transformation curve will be achieved. The marginal rate of transformation is defined by the equation:

$$| dC_{t+1}/dC_t | = | dC_t(1+r) / dC_t| = 1+r$$

The opportunity cost rate r determines the amount of consumption units that are possible in period t+1 because of suspending consumption from t to t+1 (marginal productivity of the capital).

Curve 1 displays the indifference curve of the household. This indifference curve unifies all possible combinations of the present and future consumptions that are valued equal by the household. Hence, the indifference curve provides the same level of welfare for the household. The marginal rate of substitution is defined by:

$$| dC_{t+1}/dC_t | = | dC_t(1+i) / dC_t| = 1+i$$

with i determining the interest rate, at which households are willing to delay consumption from period 0 to period 1.

Point E indicates the situation in which the marginal rate of transformation (1+r) = tg α and marginal rate of substitution (1+i) = tg α meet. Here, i obtains the same value as r what means, that the opportunity cost rate equals the time preference rate of the households.

Assuming an ideal capital market, only one interest rate will be adjusted according to the market price theory. As already stated in 2.6.1, capital markets do not resemble ideal market conditions. In reality, opportunity cost rate and time preference rate differ and hence, choice of the "correct" interest rate can not be determined appropriate to homogenise costs of projects (Bergen et al. 2002).

2.6.3 Synthetic discount rate

Since no uniform interest rate for time preference and opportunity cost rate exists, implementation of only one interest rate would blur the results. To get undistorted results, it is proposed to adopt a synthetic discount rate that includes opportunity cost rate and time preference rate (Bergen et al. 2002).

2.6.4 Social time preference rate

Presuming short sightedness and concentration on the self interest to the households, reduces the value of positive and negative effects that projects (e.g.: large scale infrastructure, afforestations) might bear for future generations. This would result in high interest rates that might reduce the feasibility of these projects. In cases where project effects are supposed to be of high importance to future generations, a lower, social discount rate might be used. Because the society as a whole will benefit from this project, since its time horizon is not as limited as the individual time horizon, this approach can be substantiated. Still the responsibility for the determination and the criteria of social time preference are not yet cleared (Bergen et al. 2002).

2.6.5 Conclusion

Having in mind the four explained approaches, leads to the finding, that no “correct“ discount rate can be determined. The individual time preference rate would fit best as it follows the concept of consumers’ sovereignty but can not defined clearly. As second best solution, the interest rate of long term, state run securities is often applied (Bergen et al. 2002). In developing countries, opportunity cost rate and individual time preference rate might differ considerable. Individual time preference rate might be very high, if a project for basic food production should be evaluated and opportunity cost rate might be very low because of low capital productivity (Götz cited in Bergen et al. 2002). In these cases it is advisable to consider different discount rates in the sensitivity analysis to avoid inadequate advices.

Finally, the real interest rate has to be determined: If real prices are selected for the CBA, the interest rate must also be calculated in real terms to avoid an interference of nominal and real values for the calculation of the Net Present Value. Real values exclude inflation rates and the real interest rate can be calculated by the following formula (Bergen et al. 2002):

$$I^r_t = i^n_t - \Pi_t \;/\; 1 + \Pi_t$$

with i^n_t = nominal interest rate and Π_t = rate of inflation.

2.7 Comparing costs and benefits

Once all advantages and disadvantages are identified and discounted with the chosen discount rate, costs and benefits are compared. Results of the comparison are either recommendation or rejection of a single project or in case of different alternatives the choice of the most beneficial one. Four criteria that descend from private investment calculation are applied: Net present value, benefit-cost ratio, internal rate of return and annuity (Bergen et al. 2002).

2.7.1 Net Present Value (NPV)

The difference of the discounted benefits and the discounted costs of a project is defined as the NPV. The already known discounting formulas (see 2.6) are applied for its determination:

$$NPV = PV(B) - PV(C) = \sum_{t=0}^{T} B_t / (1+d)^t - \sum_{t=0}^{T} C_t / (1+d)^t$$

Recommendations of projects should only be given, if the NPV is positive, meaning that the benefits of the project outbalance the costs. In case of a variety of project alternatives, NPV is the best criterion as it is not affected by different cost / benefit interpretations and the result resembles the overall gain of welfare (Bergen et al. 2002).

2.7.2 Benefit-Cost Ratio (BCR)

As the name implies, this criterion defines the ratio of discounted benefits and discounted costs.

$$BCR = PV(B) / PV(C) = \left(\sum_{t=0}^{T} B_t / (1+d)^t\right) / \left(\sum_{t=0}^{T} C_t / (1+d)^t\right)$$

If this ratio reaches a value higher than one, the project can be classified as being advantageous. Although relying on the same parameters as NPV, this criterion implies some substantial problems: Costs might be regarded as negative benefit and vice versa benefits as reduced costs, resulting in different values of the BCR (Bergen et al. 2002).

2.7.3 Internal Rate of Return (IRR)

The IRR defines the specific interest rate that balances costs and benefits. Setting the NPV zero and changing the interest rate to the variable of interest z, allows for solving the equation for z:

$$NPV = \left(\sum_{t=0}^{T} B_t - C_t\right) / (1+z)^t \overset{!}{=} 0 \quad \text{or rather} \quad \sum_{t=0}^{T} B_t / (1+z)^t = \sum_{t=0}^{T} C_t / (1+z)^t$$

The IRR is compared with a reference interest rate. Projects can be recommended if the IRR is higher than the respective reference rate. Due to its algebraic form and the problem of choosing the “right” reference interest rate, IRR might lead to problematic results (Bergen et al. 2002).

2.7.4 Annuity (AN)

NPV represents the sum of all discounted benefits that occur during the life span of the project. Annuity calculation bases on the equal portioning of this value. One portion is allocated to each period of the project and called Annuity. The sum of all discounted Annuities brings out the NPV.

$$A_N = NPV * [((1+i)^T * i) / ((1+i)^T - 1)]$$

2.8 Considering risk and uncertainty

Absolute information considering the project impacts are usually not available. Therefore, costs and benefits have to be determined with uncertainty. Risk is characterized by an objectively or subjectively determined likelihood whereas uncertainty does not rely on likelihoods (Bergen et al. 2002).

2.8.1 Risk

The determination of risk depends on a compilation of a probability distribution. This probability either bases on past observations or on educated /professional guessing.
The probability distribution defines the occurrence or absence of certain project impacts. Multiplying this probability (Pr) with the impact (e.g., project output X) leads to the expectation value (Bergen et al. 2002):

$$E(X) = Pr(1)*X(1)+Pr(2)*X(2)+\ldots+Pr(n)*X(n)$$

2.8.2 Uncertainty

If no reasonable probability distribution can be given, impacts of the project are uncertain in the narrow sense. In this case, a variety of approaches are possible:

- Maximax rule : considers the maximal achievable impact (highest maximum: best)
- Maximin rule : considers the minimal achievable impact (highest minimum: best)
- Hurwicz rule : combination of Maximax and Maximin: weighting of lowest and highest result and aggregating them to one value.
- Laplace rule : all effects are considered to have the same probability. Situation is regarded as being under risk (see 2.81)

Depending on the financial scale of a project, an appropriate rule should be applied. It is advisable to use rather conservative approaches (e.g.: Maximin) for financial significant projects. In any case it is advisable to conduct a sensitivity analysis. Consequences of different interest rates can be tested and possible effects of different scenarios (apparent as change of NPV) can be simulated. This analysis generates profound insights into the conditions that are important for an economic success of a project.

2.9 Final ranking of the alternatives

The result of a CBA is given as one value, the Net Present Value (NPV), which reflects the net welfare effect of a project. If costs of a project are lower than benefits, this value becomes positive. By comparing the NPV, alternative projects can be ranked, and, thus, a statement can be given concerning the economic feasibility against the background of economic scarcity.

3. Definition of relevant constraints

3.1 Physical constraints

A *Acacia mangium* and *Musa textilis*

Acacia mangium belongs to the family *Leguminosae*, sub-family *Mimosoideae*. *A. mangium* is native to Australia, Indonesia and Papua New Guinea, but now has a latitudinal range from 19° S to 24° N and a longitudinal range from 88° to 146° E. It is considered as a low-elevation species associated with rain forest margins and disturbed, well-drained acid soils (pH 4.5-6.5). Altitudinal range is from sea level to about 100 meters, with an upper limit of 780 meters. It is typically found in the humid, tropical lowland climatic zone characterized by a short dry season and a mean annual rainfall between 1446 and 2970 mm. *Acacia mangium* can tolerate a minimum annual rainfall of 1000 mm. Mean monthly temperatures range from a low of 13-21°C and a high of 25-32° C. Though considered as an evergreen species, *A. mangium* does not grow continuously throughout the year. Growth seems to slow or cease in response to the combination of low rainfall and cool temperatures. Dieback occurs during prolonged frost (5-6° C) (Fact Net 1996).

Musa textilis belongs to the family *Musaceae* and is indigenous to the Philippines. It is usually grown as a third phase crop in former forested areas in regions below 400m a.s.l. after a slash and burn area has become too infertile for crops like rice and corn and less nutrient demanding crops like cassava (Lacuna-Richmann 2002). The climate is tropical with an average temperature of 26-27°C and a well distributed mean annual precipitation of 2700mm (Goelthenboth & Goelthenboth 2000). Abaca is sensitive towards water logging and strong winds. It grows best on well drained volcanic soils. Cultivation requires intensive fertilization that should be applied before and after the rainy season. Fertilizers are in many cases too expensive for small scale farmers; hence plantations tend to lose in fertility after 20 years (TIF 2004). Seedling material is mostly produced by slashing the corms of younger plants into pieces as tissue cultivation is relatively expensive. Therefore, planting material can be scarce when new plantations are to be planted (TIF 2004).

Abaca can first be harvested after 18 month and transport of the stems or stripped fibres can be problematic due to the lack of roads in the rugged landscape. The production of the fibre is labour intensive and requires bargaining or renting a machine that strips the fibres (TIF 2004).

Bunchy top disease, Mosaic virus and vascular wilt are the most dangerous diseases that might attack Abaca. Especially Bunchy top disease is of economic concern, as befallen plantations might loose 90% of the plant material. This disease is transmitted by the insect *Pentalonia nigronervosa* and regulation of this pest is in most cases very difficult and expensive (TIF 2004).

Acacia mangium is mainly attacked by leaf eating insects. Pink disease (*Corticium salmonicor*) and powdery mildew (*Oidum sp.*) might hamper the growth of this tree species. The wood quality might be reduced by heart rot, ant damages (Camponotus spp.) and wood borers (*Xysterocera spp.*).Young plants are exposed to defoliation by *Hypomeces squamosus* or attacked by scale insects or mealy bugs (TIF 2004). Acacia plantations are highly susceptible to typhoons and strong winds and Abaca will be damaged by winds as well (TIF 2004).

B Rainforestation farming

Due to the high amount of tree species, the site demands for "Rainforestation Farming" (RF) are varying highly. The pH-Value of the analysed sites are varying between 4,9 and 6,5 with a mean of 5,68 and the C/N ratio of the soil ranges between 11,5 and 14,1 with a mean of 12,8 (Neusel & Schumacher 2005). Climatic requirements are generally the same as for *Musa textilis*. Exotic tree species seem to be vulnerable to strong winds and partially susceptible to insect damages (Schulte 2002) but the majority of the planted tree species is indigenous to the Philippines (Bertram 2005) and is thought to be well adopted.

The central issue of establishing a RF-site seems to be the correct choice of the tree species for the specific soil conditions (either limy or basaltic soil origin) (Schulte 2002). The choice of the well adopted tree species is confined to the limited availability of seedlings. Propagation and storing of seedlings, especial of the *Dipterocarpaceae* species, is still very complicated (Otsamo et al. 1996, Weinland 1994). Moreover, the high amount of species and the lack of knowledge about specific nursery techniques, hamper the effective production of planting material. This was also one reason why foreign species were applied in the beginning of the project (Schulte 2002). Due to the high variety of crops and tree species, number of diseases or pests that might hamper the growth RF species is considerable and might go beyond the scope of this chapter. Possible diseases and pests are listed and explained in the Appendix II (Nebel 2005).

3.2 Financial constraints

Since the analysed land-use forms are not part of a public project, no budget has to be considered. The presented afforestations schemes are already in practice. Paying attention to the economic situation of subsistence farmers, financial constraints play a major role: Long term investments that do not achieve timely near revenues are highly problematic as the farmers usually do not possess the financial background to pass on a considerable amount of money for a long period. Moreover, loans or credits are usually not available for small scale farmers on Leyte (TIF 2004).

3.3 Juridical constraints

As already discussed in the Introduction, 49% of Leyte's land area is declared as forest land where settlement and agricultural activities are officially prohibited. Illegal subsistence farmers who might apply the presented land-use forms are always concerned with uncertainty and will probably not conduct these long term production systems.

Forestry projects in the Philippines are first of all concerned by the diffuse and changing regulations on timber logging. Timber logging on private land is regulated (restricted to personal use) and requires a permit from the Department of Environmental and Natural Resources (DENR). This permit charges around 55 PhP (Philippines Peso) per tree and 30 PhP for one stem of coco palm. Farmers usually have to spend at least one day for travelling to the according authority and applying for the permit. Moreover, lacking regulation and corruption seem not to be exceptional. Harvesting private plantations on a commercial basis is permitted. DENR policy was even deregulated by allowing private registered foresters to conduct inventory and sign pertinent documents for submission to the DENR. It used to be that only DENR personnel were authorized to conduct such activities. This was done precisely to promote the establishment of private plantations. There is still a need though, that such private plantations have to be surveyed, inventoried and registered with the local DENR office (CENRO). This is intended to facilitate the issuance of the corresponding cutting and transportation permit, especially if the said logs or timber will be for sale.

In the past, individual farmers occupying areas within the classified timberland applied for a Certificate of Stewardship Contract (CSC) under the Integrated Social Forestry Programme.

In 1995, this programme was integrated together with some other programmes into the "Community Based Forest Management" (CBFM) as the national strategy for sustainable forestry and social equity (Forests and Communities 2004). This programme aims to administer 58% of the total land mass to peoples' organisation. It is an agreement between the organised communities (peoples' organisation) and the DENR that provides tenure right security for 25 years, renewable for another 25 years and incentives to develop and to manage the land, but implies complex and time intensive procedures until the final registration takes place (Forests and Communities 2004).

Once awarded with the CBFM Agreement, individual members of the PO could opt to apply for individual property rights (IPR) covering their cultivated or claimed lots within the awarded CBFM areas (which is very much like the CSC). Another mechanism which was initiated by a local government unit is co-management with the DENR. Community based watershed management is made through a "Memorandum of Agreement" (MOA) by and between the LGU and with the DENR. This mechanism is a feasible option for empowered LGUs, willing to assert their authority within the scope of the Local Government Code. There is no law that prohibits the cultivation of exotic tree species like *Acacia mangium*, *Gmelina arborea* or *Leucaena leucocephala*. The latter two are the most abundant exotic tree species in RF-sites.

3.4 Administrative constraints

Institutions and extension services for the farmers are partly given. The Institute of Tropical Ecology (ITE) at the LSU provides practical help and advices for interested farmers, especially for RF sites but also for Abaca cultivation.

Some findings of the field work in the RF sites (e.g. few fruit trees, few intercrops, too high stem density resulting in insufficient light conditions see Appendix II) indicate that either farmers do not follow given recommendations or that the extension service is not efficient in terms of giving precise instructions. Here, a comprehensive and clear guideline incorporating a schedule when to carry out thinnings and cultivate intercrops and a training of the necessary methods might enhance the economic outcome of RF sites (see 9).

3.5 Political constraints

Afforestations in general do not interfere with political aims in the Philippines. Moreover, governmental attempts to recover the residual forests and to expand the forest cover are a part of the current policy (DENR 2003). Especially the occurrence of natural catastrophes such as landslides plays a vital role in the press and in political debates and demands the necessity to promote afforestations (BBC 2003).

The main difference between governmental (represented by the DENR) and foreign approaches (here represented by the GTZ and EURONATUR) lies in the choice of tree species. While the D.E.N.R mainly promotes fast growing, exotic "wonder trees" (Schulte 2002), the GTZ and consequently EURONATUR (NGO that finances RF-projects at the moment) rather focus on a renaturalisation of the sites with indigenous tree species (Margraf & Milan 1996, Schulte 2002).

3.6 Further constraints

Besides the discussed constraints, human actions are creating or interfering with physical constraints for RF: favouring conditions for bush fires during the dry season, counterproductive damaging of tree stems with cutlass ("bolos") and other interference of people in the sites (uncontrolled grazing of water buffalos / "carabaos", and theft of intercrops, fruits or wood) are constituting distinct problems for RF and might reduce the income of RF sites considerably (Nebel 2005).

4. Selecting feasible alternatives

As already mentioned in 2.4, this analysis will be limited to agroforestry projects. The following part will roughly introduce plantations of *Acacia mangium* and *Musa textilis* and describe in detail the eleven RF-sites. Additional to the eleven analysed sites, the projection for RF sites, prepared by Dirksmeyer (2000) will be included in the economic analysis.

4.1 *Acacia mangium* and *Musa textilis*

Acacia mangium is one of the major fast growing species used in plantation forestry programs throughout Asia and the Pacific. Due to its rapid growth and tolerance of very poor soils, *A. mangium* is playing an increasingly important role in efforts to sustain commercial supply of tree products. It has rapid early growth, and can attain a height of 30 meters and a diameter of over 60 centimetres (Fact Net 1996). *Acacia mangium* is first planted (but can also be sown on steep slopes) on a cleared area (initial slashing of *Imperata* grasses) at a spacing of 2 x 5 m and Abaca is planted in the same year with a spacing of 2 x 2m. *A. mangium* will be fertilised in the first and second year. First thinning in the 6th year will reduce the spacing to 6 x 5 m. After 12 years, the rotation time ends and the stand of Acacia will be harvested, leaving some nurse trees for rejuvenation of the stand (TIF 2004).

Musa textilis has been a part in the traditional agriculture in the Philippines and its fibre is an important export good (Lacuna-Richmann 2002). As the ecological parameters of both species were already discussed in 3.1, this chapter will focus on the management of this combined plantation. *Musa textilis* requires fertilisation before and after the rainy season. Besides fertilisation, minimal work has to be invested for the cultivation. After 18 months, the first harvest can be received but harvest to full extend is only possible from the 5th year on. After 20 years, Abaca has to be replanted. The main product is the fibre of the leaves and pseudo stem (TIF 2004).

The Philippines are the most important producer of Abaca, producing around 100000 t /year. 19000 t Abaca fibres (58% on world market) are exported. Main importers of Abaca products are the UK, USA and Spain. Annual export earnings from Abaca products are to amount to 82 million US $ (mean from 1996-2000). Domestic products of Abaca are mainly pulp and paper (62%). Due to the high domestic and international demand for this biodegradable material, cultivation area of this crop increased in Leyte in the last years from 7815 ha (1990) to 15600 ha (1999). As a consequence thereof produced quantity increased from 6922 t to 8251 t (TIF 2004). Data about plantation area or world trade with *Acacia mangium* was not available.

4.2 Rainforestation farming

In the early 1990s, a holistic concept called "Rainforestation Farming" (RF) was developed in the "ViSCA-GTZ Applied Tropical Ecology Programme" by the LSU (in that time called ViSCA) together with the German technical cooperation (GTZ) (Ceniza et al. 2004). This concept aims to substitute a) the commonly used "slash and burn"-practices (in the Philippines called: "*kaingin*") and b) coconut plantations that suffer from declining productivity (Dirksmeyer 2000) by an establishment of a multi-layer continuous forest cover. These afforested sites are supposed to fulfil a variety of services, such as preserving biodiversity, maintaining the water cycle and averting soil erosion while at the same time producing income by wood and non wood products for the landowner / land user (Ceniza et. al. 2004, Dirksmeyer 2000). In 1994/1995, this concept was implemented on the farmers' level and 25 individual farmers and 3 farmers' associations established RF-sites on their land (Ceniza et. al. 2004).

Within the frame of this CBA, eleven of these sites were analysed by means of forest and soil inventories. Economic data is derived from interviews with the respective farmers and from interviews conducted by the Institute of Tropical Ecology (ITE, LSU). Data and assumptions of the model RF-site are taken over from last years CBA, based on the findings and assumptions of Dirksmeyer.

Due to the high variability between the analysed sites, no stratification could be applied. Attempts to stratify the sites by the former land-use (bare grass land or coconut stand) failed, as all sites are still or were once stocked with coco palms and information about the initial spacing of the palms was not available.

After a short introduction of the trade of forest products, the management of this land-use system will be explained. First a model of a Rainforestation farm ("RF projection") farm will be briefly introduced as it is the basis for the assumptions used for the CBA of Dirksmeyer. Finally, the analysed RF sites are presented before the results of the field survey are presented as project impacts in chapter 5.

In the year 2002 production of logs exhibited a significant slowdown with 403263 m^3 logs down by 29,4% compared to last years production in the Philippines. Likewise, production of lumber decreased by 17,2% to 163218 m^3. 6,64 million linear meters of rattan poles were produced in 2002 (DENR 2003). Nation wide, there are 63 sawmills existing with an annual log requirement of 1,07 million m^3. Small sawmills are also existing numerously in the Philippines (DENR 2003).

Log prices for the group of "Philippine Mahogany" (Dipterocarp species) are varying widely (5000-13000 PhP / m^3) depending on quality, dimension, species and location of the timber market. Lumber prices are rather uniform: Fast growing wood species like *Gmelina arborea* achieved prices around 12 PhP / board feet while Dipterocarp lumber was priced around 25 PhP / board feet in the year 2002 (DENR 2003). The total revenues from forest charges on logs were decreasing from 2001 to 2002 by 61% to 106, 4 million PhP (DENR 2003).

The increase of population and personal income will increase local demand for wood in the Philippines. Therefore a large domestic market potential exists if wood is used for construction purposes. Utilization of tropical timber for building purposes faces cultural, economic and technical constraints (lack of knowledge about physical properties, uncertainty of wood supply, absence of utility standards, poor marketing, non durability of some wood species and poor processing properties of some species). Therefore wood is mainly used for temporary constructions and only to a small extent for permanent housing. Utilisation of appropriate technology might advance affordable and comfortable housing for many people and therefore might contribute to rural development (Chong & Achmadi 1996).

4.2.1 Rainforestation farming projection (following Dirksmeyer)

Realisation of a RF site is confined by the availability of seedlings (see 3.1). If desired seedlings or plants are not available, a tree nursery has to be established to provide the necessary amount of trees. The establishment of a RF sites starts with initial undergrowth and grass clearing of the area. Residual trees or coco palms are left on the area to provide shade. If no shade is provided by the former vegetation (in most cases *Cocos nucifera*) fast growing pioneer species are planted in a spacing of 2 x 1m. The growth of these species is supposed to shade out re-growth of grasses and other weeds. If this preliminary cover is set up after one year, shade tolerant (mainly of the Dipterocarpaceae family) and fruit trees are planted in between with a spacing of 2 x 1m (Kolb 2003, Schulte 2002). In the third year 500 additional trees (species depending on availability) are planted in a way that a maximum dimensional diversity is achieved (Kolb 2003). Planting should be done after the dry season to allow the plants to grow without water stress for almost one year.

Light demanding intercrops (e.g.: bananas, sweet potatoes, other vegetables) and Rattan are being planted in between the rows from the second year on. As soon as the canopy is closed (after 8-10 years), it is recommended to cultivate shade tolerant intercrops such as Maniok (*Manihot esculenta*), Root crops (*Colocasia spp.*), Takudo (*Xanthosoma spp.*) or Mushrooms. The proper choice of the species and spacing of the intercrops determines the yield and quality of the products. Therefore great attention should be paid to match the intercrops to the stand structure (light conditions) and soil condition.

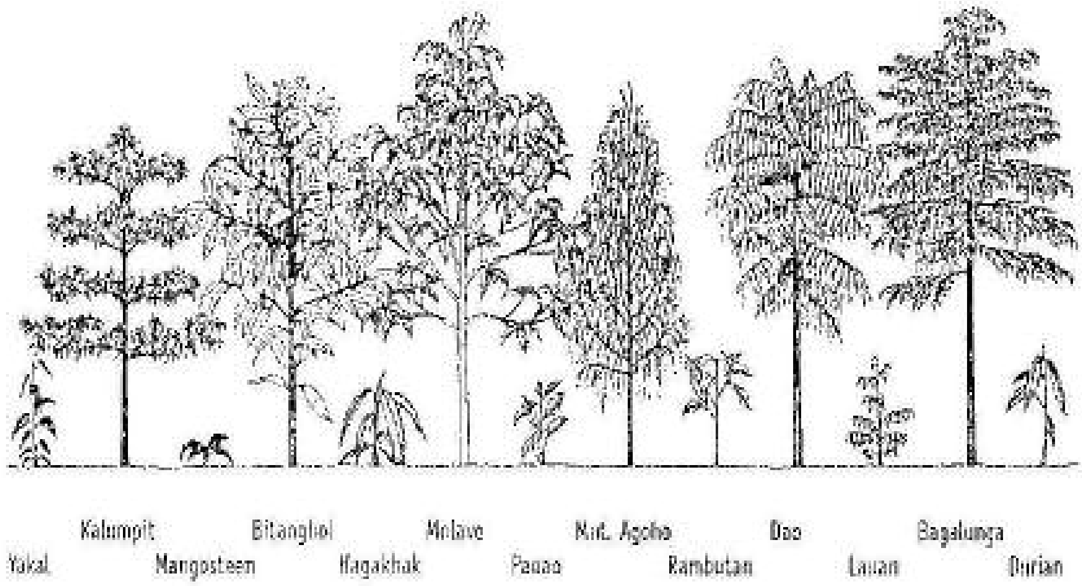

Figure 4: Desired structure of RF-sites (Schulte 2002)

4.2.2 Rainforestation farming -case studies-

During the stay in Leyte, it turned out, that a modified procedure of establishment of the analysed sites was applied. Due to the fact that in all sites, coco palms remained as nurse stand, planting of the different species classes happened simultaneously (in nine out of eleven cases). All stands were established in the years 1995 / 1996 (Ceniza et al. 2004).

Since no thinning or other silvicultural operations have taken place so far in all sites, a modified thinning proposal was applied for the economic analysis: Thinnings will take place in year 10, 15 and 20. The first thinning will harvest 20% of the stand volume (mainly pioneer species; products: mainly fuel wood and poles and few lumber), the second and third operations will each reduce the volume by 30% (products: fuel wood, poles and lumber). After the rotation time of 25 years, the stand will be clear felled and the total harvest will be sold.

Table 3: Owner, location and inclination of the RF-sites (Kiffner 2005)

Name in report	BARANGAY Name	Farmer Name	Size (ha)	Distance to road (m)	Elevation (m.a.s.l)	Exposition (n,w,s,e)	slope (°)
Cienda	Cienda	Cienda San Vicente Farmer Ass.	0,98	1500	50	Sw	0- 5
Mailhi	Mailhi	Macario Romano	0,96	200	340	sw	5 - 45
Maithum J.Garay	Maithum	Jesus Garay	0,43	200	25	nw	0 - 5
Maithum Galenzoga	Maithum	Santos Galenzoga	0,13	200	25	w	0 - 5
Marcos	Marcos	Manuel Posas	0,43	800	23	w	5 - 15
Modina	Pangasugan	Narcisio Modina	0,60	50	20	s	5 - 30
Patag	Patag	Rainforestation Assoc.	0,40	1000	28	w	5 - 20
Plaridel Lydia Tan	Plaridel	Lydia Tan	0,40	1000	600	nw	5 - 15
Plaridel R. Aberilla	Plaridel	Rogelio Aberilla	0,04	500	450	nw	5 - 10
Pomponan	Pomponan	Narceso de Jesus	0,10	6500	200	ne	15 -30
Villa	Villa de Solidaridad	Potenciana Albesa	0,29	50	360	nw	0 - 25

Most of the Rainforestation sites (RF) are located along Leyte's west coastal area at the beginning elevations of Mount *Pangasugan* around *Baybay*. Hence west expositions and slight to steep slopes are dominant (see Table 3). Two sites (*Mailhi & Villa*) are located in the central cordillera (see Figure 5). Nine out of the eleven sites belong to individual farmers, while *Patag* and *Cienda* are owned and managed by community associations (see Tab. 3). Mean area that is stocked with RF-trees is 0,43 ha (range: 0,04 to 0,97 ha).

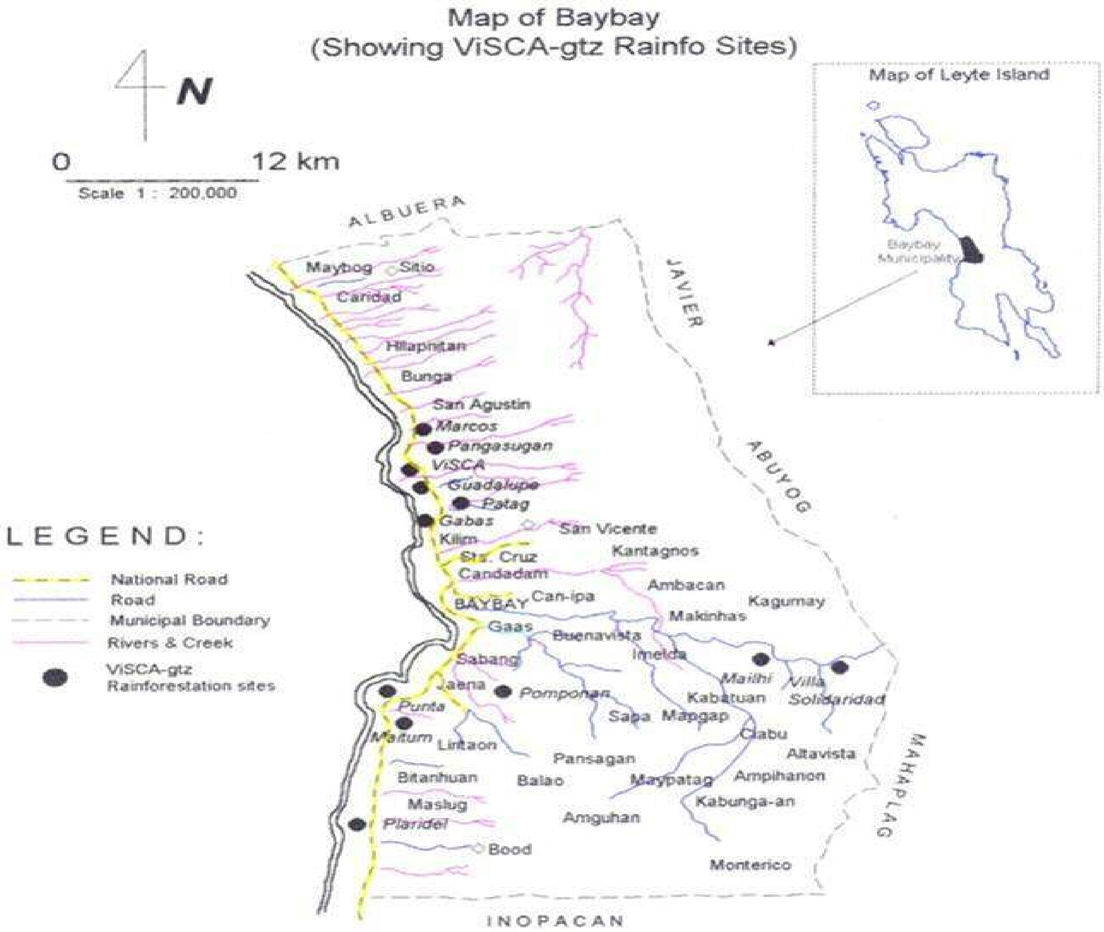

Figure 5: Location of RF-sites in Leyte (ITE 2004)

Fig 6: Desired structure of RF-site (Villa)
Fruit tree in front, Dipterocarps in the rear

Fig. 7: RF on steep slopes (Mailhi)
– effective means to stop erosion

5. Determination of project impacts

5.1 Production factor labour

Following Figure 8 (Indexmundi 2004a) unemployment rate in the Philippines increased in the last years slightly and reached 11, 4% in the year 2003.

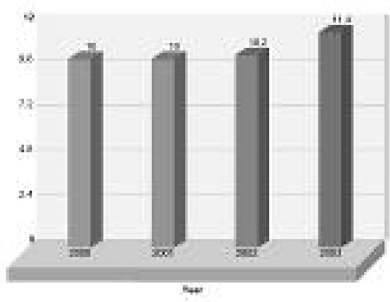

Figure 8: Unemployment rate Philippines (Indexmundi 2004a)

To deal with this aspect and to pay attention to the socio-economic conditions in the rural parts of Leyte, this analysis assumes that unemployment in its narrowest sense does not exist in rural areas. “Unemployed” people are supposed to earn their living by agricultural activities (shifting cultivation, subsistence agriculture, fishing, etc.). For this reason opportunity costs reflect average wages of non skilled labour: 100 PhP/ worker / day. Wages for non skilled labour did not increase in the last years (compare Dirksmeyer 2000, TIF 2004).

5.2 Production factor capital

For primary production –namely the forestry and agriculture sector- the value of the land plays an integral role in economic analyses. Nevertheless, in this analysis we neglect opportunity cost of capital that is fixed in land. We argue that a farmer who has to decide between various land-use alternatives (with rainforestation being one of them) has to face opportunity costs of land in any case. Thus, in- or excluding these costs, while having impact on the NPV of all alternatives considered, would not change their ranking.

5.3 External effects and public goods

5.3.1 Erosion and soil fertility

A *Acacia mangium* and *Musa textilis*

No field data was raised for soil conditions on this land type. Various examples imply that fertility of soils stocked with Abaca tend to loose in fertility (TIF 2004). Acacia seems, as well as Rainforestation farming, to be suitable for erosion precaution (Otsamo et al. 1996).

B Rainforestation sites

All analysed soils of the RF-sites can be classified as suitable for afforestations. The pH-values are considerably high, bearing in mind that soils in the tropics are tending to show low pH-values. The reason for these beneficial growth conditions for most trees can be found in the volcanic or limy parent rock material that formed the soils in Leyte (Goelthenboth & Goelthenboth 2000).

Table 4: Soil parameters of the RF-sites (Neusel & Schumacher 2005)

Name	pH	Carbon content (t/ha)	C/N ratio
Cienda	5,2	23,21	13,7
Mailhi	4,7	20,71	14,5
Maithum J.Garay	6,8	19,60	14,2
Maithum Galenzoga	6	23,52	14,7
Marcos	5,8	19,97	11,3
Modina	5,4	28,29	12,2
Patag	5,3	18,16	11,9
Plaridel Lydia Tan	5,8	20,04	11,6
Plaridel R. Aberilla	6,2	18,64	11,8
Pomponan	7,1	26,15	11,6
Villa	4,5	24,53	13,3

Data evaluation did not show an increase of C-content on the sites but slightly raising pH-values (compared with reference site) that usually improve soil fertility (Neusel & Schumacher 2005). Evidence of erosion on the sites was not detected and it can be assumed that this land use will stop erosion on the affected slopes. As data about this topic is very vague, no monetary evaluation will be applied. One farmer also mentioned that water availability improved since he established the RF site (Nebel 2005).

5.3.2 Carbon sequestration

Additional revenues generated from Clean Development Mechanisms (CDM) of the Kyoto Protocol might increase the income of forestry projects, if actually handed down to the small scale farmers. Compensation payments for carbon sequestration and the respective markets for these services are slowly developing. Additional income was conservatively calculated on the basis of a presumed low price level.

Accounting rules for temporary Certified Emission Reductions (CER) were applied for all surveyed RF sites and the *Acacia* plantation. Basing on the volume prediction and the applied thinning model, Biomass was calculated on a hectare basis [volume x 1,5 (conservative expansion factor for biomass) x density of wood (RF: 0,5 g/cm^3; Acacia: 0,65 g/cm^3)] (Richter & Gottwald 1996; Awang & Taylor 1993). Biomass was converted (multiplied by C-content: ~0,5) into tons carbon (tC) and the tons carbon were transferred into tons carbon dioxide ($tC0_2$) by multiplying with the factor 3,667 (Olschewski & Benitez 2005).

Accounting for temporary CERs is done in the following way: Credits are synchronous with the commitment periods. This means that they are issued towards the end of the respective commitment period and expire five years later at the end of the following commitment period (see Figures 9&10).

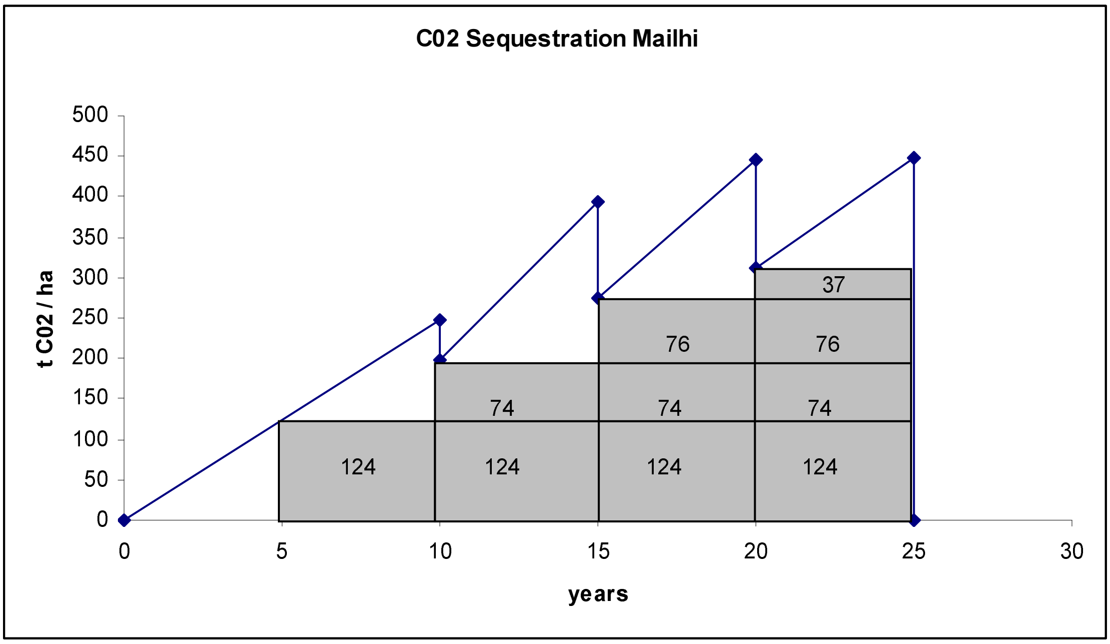

Figure 9: $C0_2$ Sequestration Rainforestation site Mailhi

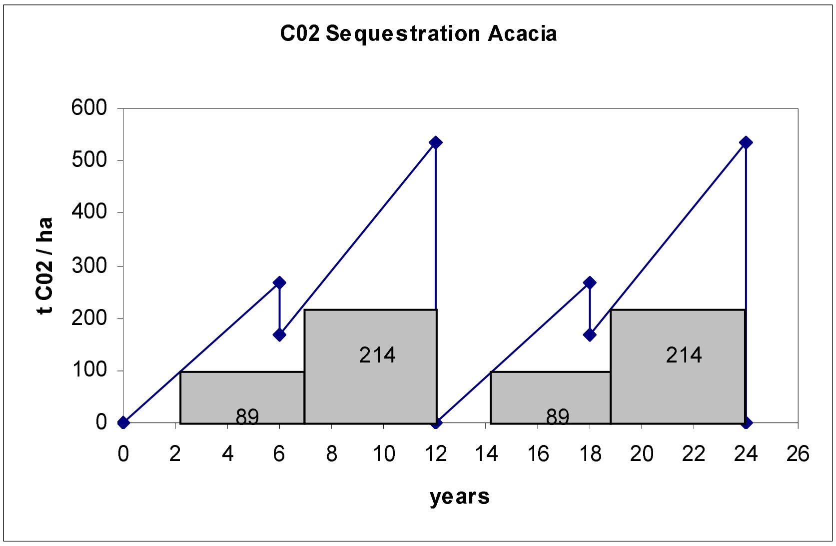

Figure 10: CO_2 Sequestration *Acacia mangium*

CER revenues are calculated with the formula: CER = p_{tCER} * t_{tCER} (price x quantity). The price for permanent CER (P_{CER})is not fixed but is expected to be around 10 US$ (PointCarbon 2004). This assumed price for permanent CERs is used for price calculation of tCERs for the three different discount rates using the formula: $P_{tCER0} = P_{CER0} - (P_{CER1}/\ (1+d)^5$ assuming a constant price level $P_{CER0} = P_{CER1}$ (Olschewski & Benitez 2005). The following table resumes the calculated prices per temporary CER (tCO_2) at the different discount rates:

Table 5: Prices of tCERS at different discount rates

4,2%	8,2%	12,2%
1,86 US$	3,26 US$	4,38 US$
102,2 PhP	179,1 PhP	240,6 PhP

The quantity is determined by a control that takes place every five years within the rotation time (see Fig. 9 & 10). Charges for registration and the control of the CERs are not considered. Additional income from tCERs are integrated in the sensitivity analysis as it is not clear, whether farmers will be able to get a registration for their afforestation.

For RF, at years 5, 10, 15 and 20, additional revenues are to be added to the cash flow and discounted with the respective discount rate. *Acacia mangium* plantations receive four additional payments. Due to the shorter rotation period, first control takes place at year 2 and the second control at year 7 in each rotation period.

5.3.3 Forest structure and tree species diversity

At the time of the inventory of the RF sites, establishment was dated back between 8 and 9 years. Therefore, increment (shown in mean diameter and basal area) can be rated as being substantial.

Table 6: Year of establishment and important stand features (Bertram 2005, Kiffner 2005)

Name	Establishment (year)	Diameter (cm)	Density (N/ha)	Basal Area (m2/ha)	Species (No)	Shannon Index
Cienda	1996	5,55	4566	24,00	40*	2,44
Mailhi	1995	6,48	3280	21,01	28	1,78
Maithum J.Garay	1996	7,01	2917	17,03	18	2,00
Maithum Galenzoga	1996	8,48	2667	22,97	11*	1,33
Marcos	1995	7,09	1882	22,50	33	2,59
Modina	1996	6,57	3516	25,94	31	2,68
Patag	1996	5,77	3900	27,86	37	2,52
Plaridel Lydia Tan	1996	6,51	3850	21,78	23	2,22
Plaridel R. Aberilla	1996	5,89	1813	6,86	8*	1,46
Pomponan	1996	12,55	2267	41,03	8*	1,47
Villa	1995	7,09	3800	24,92	35	2,56

While the exact species composition is remarkably diverse and would go beyond the scope of this CBA, the number of species found during the survey is in all sites relatively high and exceeds by far the species richness of an *Acacia mangium* and *Musa textilis* plantation (Species no.: 2, Shannon Index: 0,5). Due to a lack of data for monetary evaluation, biodiversity or diverse forest structure can not be transferred into monetary units but can be applied as a further indicator for showing that a project is advantageous.

5.4 Foreign exchange effects

Since all machines and other production factors for the compared land-use systems are produced in the Philippines, there is no need to pay special attention to the exchange rate. Domestic prices for input and outputs were calculated in Philippine Pesos (PhP). The Net Present Value will also be given in US $ for the final ranking. As there is no fixed exchange rate, the average exchange rate in 2004 of PhP 56,04 for one US $ is applied (Bangko Sentral Filipinas 2005).

* different sampling size, therefore biased comparison

5.5 Determination of costs and benefits

The time horizon chosen for this CBA is 25 years. This period seems to be reasonable for one cutting cycle of the Rainforestation sites and allows for two harvests of the other alternative *Acacia mangium* & Abaca (see 4.1). Moreover, forestry projects do not only fulfil economic tasks but are also, especially in the case of the Rainforestation sites, implemented for ecological and protection purposes. To ensure a sustainable commitment of these intentions, the rather long planning horizon of 25 years is justifiable. Furthermore, the fact that soils stocked with Abaca tend to lose fertility after 20-25 years strengthens the choice of this planning horizon. Besides, this time period still seems to be foreseeable for a farmer.

Data on costs and benefits and risk analysis aspects of the RF sites was gathered through interviews with the specific farmers and further investigations on public timber and food markets whereas ecological and inventory data bases on field work conducted in the eleven visited Rainforestation sites. Additional economic data from the last years (1995-2004) was provided by the ITE. Future quantities of timber (RF) are predicted by site specific growth models and future yield of fruit trees is determined by the current number of fruit trees per site (data from forest inventory) and the respective expected fruit yield (data from literature). Data for the demonstration farm is derived from Dirksmeyer (2000) and TIF (2004). Information about *Acacia mangium* & Abaca plantations were transferred from last years TIF-CBA on land-use systems in Leyte.

Most of the data on costs and revenues of Rainforestation Farming was collected in 2004, thus, we selected this year as the basic year "0" of the CBA. All cash flows end in the year 2029 (year 25). The costs and revenues from last years CBA were referred to the year 2004 by the inflation rate factor of 1,03 (Inflation rate 2004: 3%; Indexmundi 2004b, National Statistics Office 2004). Labour, provided by "unskilled" workers was not inflated because wages for this type of work did not increase in the last years (see 5.1).

All inputs and outputs are referred to one hectare to achieve comparability amongst the different land use systems and sites. Costs and benefits are given in Philippine Peso (PhP). As costs and benefits are each composed of two factors, namely price and quantity, these individual values are given -if available- for each alternative. Finally costs and benefits of the alternatives are presented as total and as discounted figures. The discount rate is determined at 8,2% (see 6. for justification of this rate).

To keep in the structure of this CBA, the costs and revenues of *Acacia mangium* & *Musa textilis* are given first, followed by the model RF site (both adopted from TIF 2004) and finally costs and revenues of one example of the surveyed RF sites (*Cienda*) will be given. Complete cash flows for the alternatives are to be found in Appendix I (all RF site Cash flows can be found in the digitalized Appendix).

5.5.1 *Acacia mangium* and *Musa textilis*

Costs and revenues for the single production of *Acacia* are as follows (adopted TIF 2004):

Table 7: Costs and revenues for the single production factors of *Acacia mangium* (TIF 2004)

Item	Amount (PhP)	Item (continued)	Amount (PhP)
Costs:			
Seedling production*	4541	Protection*	18447
Access and fire ponds	689	Logging and loading	277744
Land-preparation – burning	344	Cartage*	204340
Land preparation – hole digging	5786	Roading and skid formation*	40868
Land preparation – back filling	6062	Sales commission / management[*]	53128
Pest control*	596	Total costs	649306
Land preparation – ground spray*	3122	**Revenues**	
Planting-production species*	9366	Pruned logs (100m3/ha)*	476794
Fertilisation*	17312	Branched logs (150m3/ha)*	459765
Strip spraying*	6811	Pulp logs (50m3/ha)*	204341
Blanking (if required)	689	Pulp log thinning*	272454
Form pruning	661	Total revenues	1413354
Second pruning	992	**Cash flow**	**764047**
Thin to waste	1378		

Inputs: Detailed information about working input and capital input is not known. Utilised data only provided costs for categories (see Tab. 7). All production factors that seem to require capital input or skilled labour were adapted by considering the inflation rate of 2004.

Outputs: Figure 11 shows the yield development for two cutting cycles of *Acacia mangium*:

[*] extended with inflation rate of 3%.

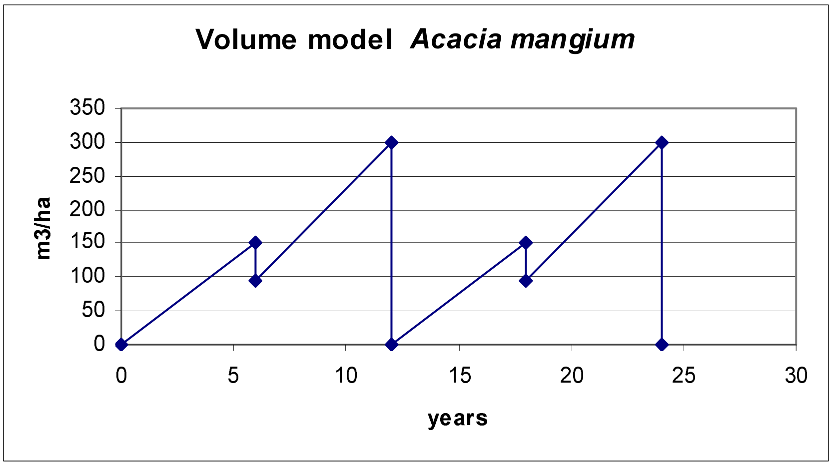

Figure 11: Volume model for *Acacia mangium*

Logs from the thinning in year 6 and from the final harvest in year 12 are mainly used for pulp production and saw logs (TIF 2003). Yield of wood is approximately 300 m3/ ha after 12 years (TIF 2004). Pruned logs make roughly 100m^3/ha, branched logs 150 m^3/ha and pulp logs 50 m^3 / ha of the final harvest. Pulp logs are the products of the thinning operation and make up to 65 m^3 / ha. Market prices of the assortments are as follows: pulp logs: 4086 PhP/m3, branched logs: 3065 PhP/m3, pruned logs: 4768 PhP/m3.

Yield of *Abaca* fibre varies between 0,31 and 1,71 t / ha (TIF 2004). Prices for Abaca depend on the grade of the fibres. A sharp rise for the price can be observed in the last years. In 1990 prices varied between 14,72 and 17,81 PhP/ kg and in 1999 prices ranged between 26,92 and 32,76 Php/kg. Abaca can be harvested after 18-24 months and needs to be replanted after 20 years (TIF 2004). Costs and revenues for the production factors of Abaca are as follows (adopted from TIF 2004):

Inputs: Establishment of Abaca plantation and most other processes are done by unskilled workers (100PhP per day). After 20 years, planting is redone but excludes some (in this situation) unnecessary working steps like “clearing”. Important production factors are fertilizer and seedlings. Planting and replanting requires 2750 plants each (price 2,06 PhP). Fertilizer is priced at 412 PhP per bag.

Table 8: Costs and revenues for the single production factors of Abaca (TIF 2004)

Item	Amount (PhP)
Costs:	
Simple workload (100 PhP/day)	493747
Skilled workload (154,5 PhP/day)*	76941
Seedlings and hauling of seed pieces*	14121
Fertilizer*	45831
Total Costs	630640
Revenues:	
Fibre*	1251450
Outer leaf sheet*	86909
Total Revenues	1338359
Cash flow	**707719**

Outputs: Yield of Abaca reaches the full extend at year 4. From there on, 1875 kg can be harvested annually. One kg Abaca is priced with 30,9 PhP. Leaf sheet production is 781 kg/ha from year 4 on and the price is 5,15 PhP per kg.

* inflated by inflation rate 3%

5.5.2 Rainforestation projection

Dirksmeyer assumed the following treatment of the stands: A first thinning will be carried out in the fifth year, taking out half of the pioneer species to increase the light conditions for trees and intercrops in the lower strata. Thinning harvest will be sold as fuel wood. Pruning will be accomplished when fruit trees or valuable trees are suppressed. Pruning and thinning operations should be accomplished with great caution towards the remaining stand (avoidance of damages in the residual stand).

The residual 50% of the pioneer species are harvested in the 12th year and sold as lumber. Fruit trees will start yielding fruits between the age of 8 or ten, depending on species and growth performance. The harvested fruits are sold at the local market. Shade tolerant trees are harvested at a DBH of 40-50 cm. Starting from the fifth year after planting (7th or 8th after the establishment) 5% of the faster growing Dipterocarp species will be harvested annually. Half of the slower growing Dipterocarps are harvested in the 18th year.

Emerging gaps are to be replanted with seedlings. Appropriate seed trees are to be left in the stand. Once this system is established, this practice should be done in the described sustainable manner. Table 9 summarises the costs and revenues of the RF projection:

Table 9: Costs and revenues for the model RF-site (TIF 2004)

Item	Amount (PhP)
Costs:	
Seedlings slow-gr, sun demanding*	248
Seedlings fast-gr, sun demanding*	3371
Seedlings slow-gr, shade demanding*	312
Seedlings fast-gr, shade demanding*	3268
Seedlings fruit trees*	3222
Labour for trees	1589954
Total costs for trees	**1600375**
Labour for Intercrops	**57432**
Total costs	1657807
Revenues:	
Slow-gr. Sun demanding lumber*	151132
Fast-gr. Sun demanding fuel wood*	3474

Inputs: Labour is the most important production factor of RF. Again, cited literature does not provide detailed information about the working input for the different working steps (clearing the area, planting, tending, harvesting, etc.)

Fertilizers are not needed for this projection. Main capital input is needed for purchasing seedlings. Seeds or plants for Intercrops are assumed to be gained for free from own stocks or from neighbouring farmers.

* price inflated by inflation rate 3%

Fast-gr. Sun demanding lumber*	2155664
Slow-gr. Shade demanding poles*	34081
Fast-gr. Shade demanding poles*	210088
Fast-gr. Shade demanding Lumber*	220716
Fruits*	969269
Fruit trees: poles*	19551
Total revenues trees:	**3763975**
Banana*	98767
Pineapple*	870051
Other fruits*	150216
Tacudo*	407386
Camote*	148151
Abaca*	264305
Total revenues Intercrops	**1938876**
Total revenues	5702851
Cash flow	**4045044**

Outputs: Main outputs of RF are intercrops in the first years and in the long run the timber trees. Due to the logging ban, market prices for the timber species do not exist. Dirksmeyer used prices of "black" market timber prices to estimate "true" market prices of the different assortments and species. Lumber was categorized to facilitate calculations

Dirksmeyer assumed prices for timber that range between 12 and more than 50 PhP per board feet.

*price inflated by inflation rate 3%

5.5.3 Rainforestation farming –case studies-

The following financial analysis of eleven RF sites bases on data that was derived by interviews with the respective farmer and own projections that might be rather optimistic. Therefore, a sensitivity analysis was conducted to avoid overestimations that might lead to a too positive view of this land use system.

Utilising the provided information about the costs and revenues from the last years (provided by ITE and prices referred to 2004) and the growth and yield models, costs and revenues were determined for each Rainforestation site. Assumptions on the future inputs and outputs are summarised in the Appendix II (Derwisch & Schneider 2005). Due to the high variability amongst the sites, costs and incomes are varying considerably. To simplify, one "representative" site was chosen to illustrate costs and revenues:

Table 10: Costs and revenues for the surveyed RF-sites (*Cienda*) (Derwisch & Schneider 2005)

Item	Amount (PhP)
Brushing	11762
Lay-outing	15290
Staking	25484
Hauling	10194
Digging	25484
Planting	15290
Total costs Labour:	**103503**
Fruit trees	**136369**
Forest trees	**30348**
Sweet potato	915
Peanuts	3548
Taro	1634
Other Vegetables	2368
Ginger	2128
Total Intercrops	**10593**
Pruning/Thinning/brushing	256335

Item (continued)	Amount (PhP)
Replacement planting	19775
Total tending:	**276654**
Harvesting timber	**1323675**
Harvesting Fruits	**775586**
Harvesting Intercrops	**6029**
Barbed wire	**1464**
Fertilizer	**573**
Total costs	**2664794**
Revenues:	
Timber	**4080329**
Fruits	**2587485**
Intercrops	**23460**
Total revenues	**6691274**
Cash flow	**4026480**

Inputs: Costs for establishing this specific site is 100470 PhP. Compared with the projections of Dirksmeyer, labour input is not as dominant. Unlike the projection described in 5.51 B, farmers had to pay for intercrops and were not able to collect seeds, seedlings or plants from own stocks or for free from other sources.

Outputs: The most important output of RF farms is timber. A simple growth model was fitted to the different stands to estimate the wood volume that might be sold after future forest operations.

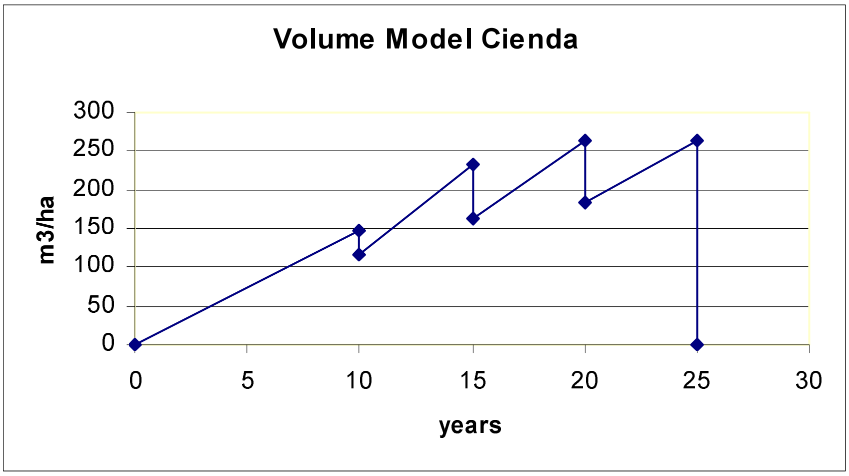

Figure 12 illustrates the simplified growth and the three thinnings at age 10, 15, 20 and the final cutting at year 25 for one example site (Mailhi). Table 11 pools the accumulating volumes at the respective ages for all sites.

Figure 12: Volume model for *Cienda* (modified following Englert & Kaiser 2005)

Table 11: Accumulating volumes of the forest operations (Englert & Kaiser 2005)

Name	Year 10 (m3/ha)	Year 15 (m3/ha)	Year 20 (m3/ha)	Year 25 (m3/ha)
Cienda	34,2	81,2	92,0	308,3
Mailhi	29,3	69,7	78,9	264,5
Maithum J.Garay	31,6	75,1	85,0	284,9
Maithum Galenzoga	36,1	85,8	97,2	325,84
Marcos	45,4	107,8	122,1	409,1
Modina	55,1	130,9	148,2	496,8
Patag	77,8	184,7	209,2	701,4
Plaridel Lydia Tan	39,5	93,9	106,4	356,5
Plaridel R. Aberilla	6,5	15,4	17,4	58,5
Pomponan	95,6	227,1	257,2	862,1
Villa	37,3	88,5	100,3	336,1

The accumulating wood volumes are presumed to be allotted in the quality assortments fuel wood, poles and lumber in the following contingents:

Table 12: Share of the wood products at forest operations (Derwisch & Schneider 2005)

	Year 10		Year 15		Year 20		Year 25	
	Climax	**Pioneer**	**Climax**	**Pioneer**	**Climax**	**Pioneer**	**Climax**	**Pioneer**
Fuelwood	0,7	0,5	0,5	0,4	0,5	0,4	0,3	0,3
Poles	0,3	0,3	0,5		0,5			
Lumber		0,2		0,6		0,6	0,7	0,7

This projection assumes that the first thinning will mainly provide low quality and small dimensional timber. With increasing age and dimension of the trees, more valuable wood products can be harvested. It is not expected that forest products of the RF-sites will be exported. Wood products will be traded on local markets and achieve following prices.

Table 13: Prices for the different timber assortments (Derwisch & Schneider 2005)

Assortment	**Fuel wood**	**Poles**	**Lumber**
Price (PhP)	535	1954	12720

A similar projection was accomplished for yields of fruit trees that were found on the respective sites. Fruit trees are mainly planted in *Cienda*, *Mailhi*, *Marcos*, *Modina*, *Patag*, *Plaridel Lydia Tan* and *Villa* (see Appendix II). The other four sites lack any mentionable number of fruit bearing trees. Table 14 pools the expected quantities of fruits and the respective market prices:

Table 14: Fruit yield and prices of common fruit tree species (Derwisch & Schneider 2005)

Fruit	**Yield/tree/year**		**Fr. time**	**Price**	
	kg	**Fruits**		**PHP/ kg**	**PHP/ fruits**
Areca catechu	-	-	-	-	-
Avocado	25		5	10	
Cacao	0,33		5	100	
Carambola	-	-	-	-	-
Coconut	10,8		7	17,30	
Coryphe ulan	-	-	-	-	-
Diplodiscus p.	-	-	-	-	-
Durian	112,5		12	60	
Flacourtia j.	-	-	-	-	-
Guava	40		3	5	
Guyabano	4,8		4	7	
Jackfruit		200	9		200
Lanzones	35		16	45	
Mango	75		6	45	
Mangosteen	125		15	25	
Marang	-	-	-	-	
Papaya	34		1	55	
Rambutan	48		6	20	
Santol	-	-	-	-	-

6. Discounting costs and benefits

6.1 Selected discount rate

As described in the chapters 2.6 to 2.6.5, selection of an adequate interest rate is rather difficult. Due to the problems that occur when applying the described approaches, this CBA utilises the second best yardstick, the interest rate for long term state securities, to calculate the discount rate.

According to the formula for the real interest rate (see 2.65), the nominal interest rate of 11,46% for 10 year treasury bonds (Bangko Sentral Filipinas 2004) and the inflation rate of 3% (Indexmundi 2004b & National Statistics Office 2004) was used to compute the applied real interest rate (I^r_t):

$$I^r_t = (0{,}1146 - 0{,}03) / 1{,}03$$

$$I^r_t = 0{,}082 = 8{,}2\%$$

Due to the difficulties in finding the "correct" interest rate, a sensitivity analysis was conducted in order to avoid wrong decisions. To achieve a broad spectrum of possible results, further discount rates of 4,2% and 12,2% were chosen. The low discount rate might reflect a situation in which loans are provided at cheap conditions (e.g.: from development cooperation) while the high discount rate rather reflects the discount rate used by the Asian Development Bank when conducting economic analysis in development countries (ADB 2004b). By computing the results with different interest rates, one attains the influence of discount rates on the result of each alternative.

6.2 Discounting costs and benefits

The results of the discounted costs and benefits are displayed in the following table 15. Calculation of present values is computed according to chapter 2.6. This table also shows the results of the sensitivity analysis with chosen discount rates of 4,2% and 12,2%. All figures are given in PhP.

Table 15: Discounted costs and benefits per ha of all alternatives with different discount rates

Alternative		**Discount rate**		
Acacia/Abaca		4,2%	**8,2%**	12,2%
Discounted costs		747812	**497448**	359667
Discounted benefits		1543870	**977106**	665676
RF-projection		4,2%	**8,2%**	12,2%
Discounted costs		1003006	**686204**	508487
Discounted benefits		3064434	**1831465**	1170045
RF-sites	**Discounted**	4,2%	**8,2%**	12,2%
Cienda	Costs	1382433	**898048**	675118
	Benefits	2727869	**1271071**	629937
Mailhi	Costs	2893750	**1600064**	998048
	Benefits	8199465	**4007070**	2070755
Maithum J.G	Costs	553433	**284339**	168718
	Benefits	1482435	**664266**	316715
Maithum G.	Costs	873296	**535872**	383592
	Benefits	2656072	**1622648**	1149624
Marcos	Costs	6657126	**3314063**	1755319
	Benefits	21407121	**10436044**	5329026
Modina	Costs	7260272	**5838558**	1819175
	Benefits	23704797	**18993285**	5768545
Patag	Costs	1693848	**925530**	591308
	Benefits	5059528	**2559180**	1436445
Plaridel L.T.	Costs	61199938	**2985438**	1557818
	Benefits	21723363	**10502888**	5315988
Plaridel R. A.	Costs	2364480	**2249413**	2179040
	Benefits	742560	**518693**	407413
Pomponan	Costs	1482653	**779863**	487347
	Benefits	4316158	**2043147**	1087105
Villa	Costs	8693631	**4823017**	2858752
	Benefits	27966966	**15198600**	8729783
Average RF-site	Costs	8641351	**2203110**	1224930
	Benefits	10907848	**6165172**	2931031

The next chapter analyses these findings by applying the decision criteria explained in chapter 2.7.

7. Comparing costs and benefits of the selected alternatives

Table 16 gives an overview of all decision criteria. Considering the Net Present Value (NPV), the RF sites of *Villa*, *Modina*, *Plaridel Lydia Tan* and *Marcos* reach by far the highest value. The "average" RF site also reaches higher values than *Acacia/Abaca* and the projection of Dirksmeyer. On the other hand, *Plaridel R.A* achieves a negative NPV and the NPV of *Cienda* turns negative when the discount rate is increased to 12,2%. This shows that the differences amongst the Rainforestation sites are considerable. Applying different discount rates does not change the ranking of the alternatives.

NPV and Annuity lead to the same ranking, while BCR results may differ from NPV ranking. This can be seen when comparing Mailhi (with a NPV of 2.4 million PhP and a BCR of 2.5), and Maithum G. (with a lower NPV of about 1 million PhP, but a higher BCR of 3.0). In Maithum G. the evaluated overall project in- and output per hectare is lower than in Mailhi, resulting in a lower net welfare effect (given by the NPV). However, when comparing BCR, Maithum reaches a better result due to the higher average benefits achieved per cost unit (given by the BCR). IRR gives ambiguous results in some cases, which might be due to the algebraic form (see 2.7.3).

Table 16: Decision criteria of all alternatives at different discount rates

Acacia/Abaca	4,2%	**8,2%**	12,2%
NPV (PhP)	796057	**479658**	306009
Annuity (PhP)	52040	**45704**	39559
Benefit Cost Ratio	2,06	**1,96**	1,85
Internal Rate of Return (IRR)		**45%**	

RF-projection	4,2%	**8,2%**	12,2%
NPV (PhP)	2061428	**1.145260**	661.558
Annuity (PhP)	134760	**109125**	85.521
Benefit Cost Ratio	3,06	**2,83**	2,30
Internal Rate of Return (IRR)		**39%**	

RF-sites	**Criteria**	4,2%	**8,2%**	12,2%
Cienda	NPV (PhP)	1345434	**373024**	-45181
	Annuity (PhP)	87954	**35543**	-5840
	Benefit Cost Ratio	1,97	**1,42**	0,93
	IRR		**12%**	

Mailhi	NPV (PhP)	5305715	**2407005**	1072707
	Annuity (PhP)	346847	**229350**	138672
	Benefit Cost Ratio	2,83	**2,50**	2,07
	IRR		**22%**	
Maithum J.G.	NPV (PhP)	929002	**379929**	147998
	Annuity (PhP)	60732	**36202**	19132
	Benefit Cost Ratio	2,68	**2,34**	1,88
	IRR		**20%**	
Maithum G.	NPV (PhP)	1782776	**1086776**	766040
	Annuity (PhP)	116544	**103552**	99024
	Benefit Cost Ratio	3,04	**3,03**	3,00
	IRR		**173%**	
Marcos	NPV (PhP)	14749995	**7121981**	3573705
	Annuity (PhP)	964240	**678614**	461981
	Benefit Cost Ratio	3,22	**3,15**	3,04
	IRR		**38%**	
Modina	NPV (PhP)	16444525	**7890843**	3949372
	Annuity (PhP)	1075015	**751873**	510545
	Benefit Cost Ratio	3,27	**3,23**	3,17
	IRR		**47%**	
Patag	NPV (PhP)	3363180	**1633653**	845138
	Annuity (PhP)	220023	**155663**	109253
	Benefit Cost Ratio	2,99	**2,77**	2,43
	IRR		**30%**	
Plaridel L.T.	NPV (PhP)	15603425	**7517453**	3758170
	Annuity (PhP)	1020030	**716295**	485830
	Benefit Cost Ratio	3,55	**3,52**	3,41
	IRR		**38%**	
Plaridel R. A.	NPV (PhP)	-1621893	**-1730720**	-1771627
	Annuity (PhP)	-106027	**-164907**	-229013
	Benefit Cost Ratio	0,31	**0,23**	0,19
	IRR		**-**	

Pomponan	NPV (PhP)	2833505	**1263284**	599758
	Annuity (PhP)	185232	**120368**	77537
	Benefit Cost Ratio	2,91	**2,62**	2,23
	IRR		**34%**	
Villa	NPV (PhP)	19273334	**10375583**	5871028
	Annuity (PhP)	1259941	**988631**	758962
	Benefit Cost Ratio	3,22	**3,15**	3,05
	IRR		**52%**	
Average RF-site	NPV (PhP)	7273545	**3483528**	1706101
	Annuity (PhP)	475503	**331926**	220553
	Benefit Cost Ratio	2,72	**2,54**	2,31
	IRR		**42%**	

8. Considering risk and uncertainty

Meanwhile, all considered land-use systems are practised by small scale farmers in Leyte. Most of the farmers rely only on the income of their owned respectively leased land. Therefore a "wrong" decision of the type of land use would seriously impact the financial and overall situation of the concerned household. To avoid a "wrong" choice or recommendation, it is important to consider risk and uncertainty (see 2.8). As possible scenarios for *Abaca/Acacia* (Diseases) and the RF projection (no logging permit) have already been discussed in last year's CBA, this chapter will focus on three negative scenarios for the analysed RF sites and on one positive scenario (payments for Carbon Sequestration). Due to the weak database and the short time period since Rainforestation started, future developments about quantity, quality and prices of products are still uncertain.

8.1 Carbon sequestration

This positive scenario assumes that the trade of Certified Emission Reductions (CER) in the frame of the Clean Development Mechanisms of the Kyoto Protocol will be realised (see 5.32). The following table summarises the additional revenues from selling temporary CERs for all eleven RF sites and Acacia at different discount rates. Revenues are given in PhP.

Table 17: Additional Revenues from Carbon Sequestration at different interest rates

Acacia / Abaca		Year 2	Year 7	Year 14	Year 19
CER (t CO_2)		*89,0*	*214,0*	*89,0*	*214,0*
4,2 %		165,5	397,9	165,5	397,9
8,2 %		**289,9**	**697,0**	**289,9**	**697,0**
12,2 %		389,5	936,5	389,5	936,5
RF-sites		Year 5	Year 10	Year 15	Year 20
Cienda	*CER (t CO_2)*	117,6	188,1	260,2	294,7
	4,2 %	12010	19218	26580	30102
	8,2 %	**21037**	**33662**	**46556**	**52731**
	12,2 %	28267	45227	62555	70856
Mailhi	*CER (t CO_2)*	*100,9*	*161,4*	*223,2*	*252,8*
	4,2 %	10301	16482	22800	25822
	8,2 %	**18048**	**28876**	**39936**	**45232**
	12,2 %	24251	38799	53660	60780
Maithum J.G.	*CER (t CO_2)*	*108,7*	*173,9*	*240,5*	*272,4*
	4,2 %	11098	17757	24564	27822
	8,2 %	**19443**	**31107**	**43024**	**48732**
	12,2 %	26124	41798	57813	65483

Maithum G.	*CER (t CO_2)*	*124,3*	*198,8*	*275,0*	*311,5*
	4,2 %	12691	20311	28091	31816
	8,2 %	**22234**	**35574**	**49204**	**55731**
	12,2 %	29876	47798	66109	74883
Marcos	*CER (t CO_2)*	*156,0*	*249,6*	*345,3*	*391,1*
	4,2 %	15938	25498	35271	39947
	8,2 %	**27915**	**44666**	**61780**	**69977**
	12,2 %	37513	60016	83009	94024
Modina	*CER (t CO_2)*	*189,5*	*303,1*	*419,3*	*474,9*
	4,2 %	19355	30964	42826	48507
	8,2 %	**33898**	**54237**	**75015**	**84970**
	12,2 %	45551	72878	100798	114171
Patag	*CER (t CO_2)*	267,5	427,9	591,9	670,4
	4,2 %	27322	43716	60461	68483
	8,2 %	**47858**	**76570**	**105908**	**119956**
	12,2 %	64307	102886	142306	161183
Plaridel L.T.	*CER (t CO_2)*	*136,0*	*217,5*	*300,9*	*340,8*
	4,2 %	13889	22223	30733	34810
	8,2 %	**24327**	**38925**	**53836**	**60978**
	12,2 %	32689	52303	72339	81938
Plaridel R. A.	*CER (t CO_2)*	*22,3*	*35,7*	*49,3*	*55,9*
	4,2 %	2275	3643	5038	5708
	8,2 %	**3989**	**6379**	**8823**	**9999**
	12,2 %	5357	8576	11856	13433
Pomponan	*CER (t CO_2)*	***328,8***	***526,0***	***727,5***	***824,1***
	4,2 %	33585	53731	74317	84179
	8,2 %	**58824**	**94118**	**130175**	**147448**
	12,2 %	79042	126466	174912	198125
Villa	*CER (t CO_2)*	*128,2*	*205,1*	*283,6*	*321,2*
	4,2 %	13092	20949	28970	32816
	8,2 %	**22932**	**36689**	**50748**	**57478**
	12,2 %	30810	49303	68186	77235
Average RF-site	*CER (t CO_2)*	*152,7*	*244,3*	*337,9*	*382,7*
	4,2 %	15597	24954	34513	39090
	8,2 %	27316	43710	60456	68477
	12,2 %	36705	58731	81234	92008

8.2 Low timber quality

Timber is the main product of the RF sites. Estimates of future timber assortments are inflicted with a high uncertainty. Since prices for different timber qualities are varying considerably (see 5.53 Table 12), shift of assortments to lower quality have a high impact on the income. Therefore NPV for all RF sites were calculated by using a pessimistic timber quality expectation:

Table 18: Share of the wood products at forest operations (pessimistic projection)

	Year 10		Year 15		Year 20		Year 25	
	Climax	**Pioneer**	**Climax**	**Pioneer**	**Climax**	**Pioneer**	**Climax**	**Pioneer**
Fuel wood	0,9	0,8	0,7	0,6	0,6	0,6	0,6	0,6
Poles	0,1	0,2	0,3		0,4			
Lumber				0,4		0,4	0,4	0,4

8.3 Timber yield decline

This scenario includes decline in timber yield by one third. Paying attention to the insufficient data base and unknown future revenues, the Laplace rule was applied. Decline in timber yield could be due to overestimated tree growth, diseases and pests that befall trees (see Appendix II, Nebel 2005) or inadequate growth conditions as a consequence of poor light conditions in the stand. Typhoons are also common in this region and might damage trees. Decline in yield could also be traced back to the widespread phenomena of theft or other negative human impact such as promoting fire.

8.4 Intercrop and fruit yield decline

Analogous to the scenario of timber yield decline, production of intercrops and fruits was assumed to be reduced by one third. Possible reasons for decline are generally the same as described for timber production. Reduced light conditions and human impact such as theft might be of higher relevance than in the timber yield scenario.

8.5 Sensitivity analysis

The above mentioned scenarios were integrated in the Cash flows of all RF sites. Carbon sequestration was also considered for the Acacia plantation. All costs and revenues with the "new" assumptions were calculated with a discount rate of 8,2 %. NPV as a total figure (in PhP/ ha) and as percentage of the initial value are given for the considered alternatives:

Table 19: NPV considering risk and uncertainty (discount rate of 8,2 %)

Scenario / Alternative	*Initial NPV*	Carbon Sequestration	Low timber quality	Timber yield decline	Fruit and intercrop yield decline
Acacia/Abaca	***479658***	566970	-/-	-/-	-/-
%	***100***	118,2	-/-	-/-	-/-
Cienda	***373024***	427692	177486	212975	286050
%	***100***	114,7	47,6	57,1	76,7
Mailhi	***2407005***	2453902	2229285	2261636	1865635
%	***100***	102,0	92,6	93,9	77,5
Maithum J.G	***379929***	430451	198952	231936	379928
%	***100***	113,0	52,4	61,1	99,9
Maithum G.	***1086776***	1144556	899158	923736	1086779
%	***100***	105,0	82,7	85,0	100,0
Marcos	***7121981***	7194526	6909615	69486139	4641825
%	***100***	101,0	97,0	97,6	65,2
Modina	***7890843***	7978932	7586844	7638482	7889616
%	***100***	101,0	96,1	96,8	99,9
Patag	***1633653***	1760660	1177112	1254070	1586923
%	***100***	107,0	72,1	76,8	97,1
Plaridel L.T	***7517453***	7580669	7287359	7323415	5743608
%	***100***	101,0	96,9	97,4	76,4
Plaridel R. A.	***-1730720***	-1720354	-1767048	-1760413	-1733675
%	***100***	101,0	97,9	98,3	99,8
Pomponan	***1263284***	1428676	779081	869012	1260362
%	***100***	113,1	61,7	68,8	99,8
Villa	***10375583***	10431827	10174021	10209826	7068062
%	***100***	101,0	98,1	98,4	68,1
Average RF %	***100***	**105,4**	**81,4**	**84,7**	**87,3**

The sensitivity analysis reveals that most RF sites are -even under unfavourable conditions- more beneficial than *Acacia/Abaca* plantations and the overall ranking will not be changed.

Considering the negative scenarios, low timber quality will have the strongest impact on the NPV of each site: But even if poor timber qualities will be the main output, the NPV is in most cases still advantageous and does not turn negative (except for *Plaridel R. A.* that always achieves negative NPV). Different sites will react differently to decrease of fruit and timber yield because the share of these products is varying considerably (e.g.: some sites lack any mentionable amounts of fruit trees; see Appendix II, Bertram 2005, Kiffner 2005). Overall, decrease in timber yield and timber quality lower the NPV to a high extent, implying that timber is the main output of average RF sites. It should be mentioned, that decrease in intercrop and fruit yield is only of importance for sites that achieve a high initial NPV. This finding indicates that these products play a key role for the economic success of these RF sites.

Additional income from CERs might increase the NPV considerably. Especially sites that do not achieve high NPV and have little early income from intercrops will benefit most from this income. Income from CER could be of high importance if the discount rate will increase for any reason: While all revenues from RF (especially from the long term production of timber) will decrease, income from CERs is increasing as the price will go up (see 5.32 Tab. 5). Acacia achieves the highest relative NPV increase if CERs are incorporated in the analysis. This might be traced back to the fast growth of Acacia and moreover to the early moment when the first revenue will be received.

9. Conclusions and recommendations

Comparing the Net Present Value (net welfare contribution) of each alternative allows for an overall ranking: From an economic point of view, most sites are profitable; only alternative *Plaridel R. A.* should be rejected. This alternative generates negative results in any scenario. Even additional income from CERs will not put this alternative into a positive outcome. The reason for the negative result can be traced back to a forest fire that destroyed most of the afforested area. Therefore high establishment costs were confronted with low income. As forest fires are a general problem for any kind of forestry land use, this scenario was not included in the analysis.

Table 20: Final ranking of all alternatives; Criterion: NPV at discount rate of 8,2 %

Rank	Alternative	NPV (PhP)	NPV (US $)
1	**Villa**	**10375583**	**185146**
2	**Modina**	**7890843**	**140807**
3	**Plaridel L.T.**	**7517453**	**134144**
4	**Marcos**	**7121981**	**127087**
5	**Average RF-site**	**3483528**	**62161**
6	**Mailhi**	**2407005**	**42952**
7	**Patag**	**1633653**	**29152**
8	**Pomponan**	**1263284**	**22543**
9	**RF-projection (Dirksmeyer)**	**1145260**	**20436**
10	**Maithum G.**	**1086776**	**19393**
11	**Acacia/Abaca**	**479658**	**8559**
12	**Maithum J.G**	**379929**	**6780**
13	**Cienda**	**373024**	**6656**
14	**Plaridel R. A.**	**-1730720**	**-30884**

Cienda achieves a relative low NPV. This might be due to unfavourable soil conditions in the northern part of the area (Kolb 2003). At a discount rate of 12,2% NPV turns negative but will produce a welfare gain of 5562 PHP if additional income from carbon sequestration can be realised. Additionally, it is doubtful if *Abaca/Acacia* will perform better on this soil.

Eight RF sites achieve higher NPVs than *Abaca/Acacia* and seven even exceed the projection of Dirksmeyer. The main result of the ranking of the alternatives does not change when the described "pessimistic" scenarios do occur. The sensitivity analysis reveals that the most successful sites are those that depend in a large extend on income from fruits and intercrops. Furthermore, the achieved timber qualities have considerable impact on the economic success of RF sites. The overall advantage of the surveyed RF sites compared to the projection of Dirksmeyer might be traced back to the final complete harvest of the stand. This setting was assumed to be very likely as land tenure is usually not secure or land leases only last for a certain time period. Despite this assumption, this management practice is not recommended and the aim of RF should be to secure a continuous forest cover.

Although this CBA attributes a welfare gain for most RF sites even under unfavourable conditions (see 8.2), it is unclear if these positive results can indeed be achieved. Extreme pessimistic scenarios that were not included in the sensitivity analysis or combinations of the described scenarios might appear in future and reduce the NPV to a high extent (see *Plaridel R.A*). Therefore, it is advisable to carefully monitor the development of the sites before promoting RF on a large scale. Despite all uncertainties, RF might bear a lower risk due to the high species diversity compared to monocultures or comparable plantations structures.

Besides the advantageous economic effects of most RF sites, the positive ecological effects should be mentioned here. Forest structure and tree composition of RF sites do not only promote indigenous floral species diversity but also improve faunal species diversity (Ceniza et al. 2004). Other external effects and public goods such as avoiding erosion or carbon sequestration are probably achieved in the same quality by all alternatives. Nevertheless the small extent of the surveyed RF sites might reduce the mentioned positive ecological impacts. Analysing these findings about RF sites leads to the following recommendations:

- Juridical constraints for forestry projects have to be reduced: land tenure security should be guaranteed and issuing of utilisation permits on own land and of own trees should be simplified.
- Research about effective RF-species compositions -including intercrops and fruit trees- should be enhanced.
- Monitoring of RF-sites has to be intensified to learn more about the possible economic and ecological development of RF sites.
- Means to reduce forest fires and other negative human impact on RF sites should be established. Fuel-void fire control strips around RF sites should be recommended.
- RF-species seedling propagation should be enhanced.
- RF-species seedlings as the main production factor input should be provided or a micro finance system should be established to ensure that farmers can invest in RF.
- Adequate extension service should be provided to help the farmers in improving the economic output of RF farms (management plan, timing of forest operations, technique of intercropping, practical training in timber harvesting etc.).

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Appendix A

Abaca Cash flow table

Years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
simple Workload	16.600	14.491	15.988	17.483	20.479	20.479	20.479	20.479	20.479	20.479	20.479	20.479	20.479	20.479	20.479	20.479	20.479	20.479	20.479
skilled Workload	0	1.391	2.163	2.936	3.554	3.554	3.554	3.554	3.554	3.554	3.554	3.554	3.554	3.554	3.554	3.554	3.554	3.554	3.554
Seedlings and hauling of seedpieces	7.040																		
Fertilizer	2.122	2.122	1.697	1.697	1.697	1.697	1.697	1.697	1.697	1.697	1.697	1.697	1.697	1.697	1.697	1.697	1.697	1.697	1.697
Total Costs	**25.762**	**18.003**	**19.848**	**22.116**	**25.730**	**25.730**	**25.730**	**25.730**	**25.730**	**25.730**	**25.730**	**25.730**	**25.730**	**25.730**	**25.730**	**25.730**	**25.730**	**25.730**	**25.730**
Fiber	0	23.175	34.763	46.350	57.938	57.938	57.938	57.938	57.938	57.938	57.938	57.938	57.938	57.938	57.938	57.938	57.938	57.938	57.938
Outer leaf sheet	0	1.609	2.414	3.219	4.023	4.023	4.023	4.023	4.023	4.023	4.023	4.023	4.023	4.023	4.023	4.023	4.023	4.023	4.023
Total Revenues	**0**	**24.784**	**37.177**	**49.569**	**61.961**	**61.961**	**61.961**	**61.961**	**61.961**	**61.961**	**61.961**	**61.961**	**61.961**	**61.961**	**61.961**	**61.961**	**61.961**	**61.961**	**61.961**
Cash Flow	**-25.762**	**6.781**	**17.329**	**27.453**	**36.231**	**36.231**	**36.231**	**36.231**	**36.231**	**36.231**	**36.231**	**36.231**	**36.231**	**36.231**	**36.231**	**36.231**	**36.231**	**36.231**	**36.231**
Discounted Cash Flow	-25.762	6.267	14.802	21.672	26.434	24.431	22.580	20.868	19.287	17.825	16.474	15.226	14.072	13.005	12.020	11.109	10.267	9.489	8.770

Years	19	20	21	22	23	24	25
simple Workload	20.479	20.479	12.600	14.491	15.988	17.483	20.479
skilled Workload	3.554	3.554	0	1.391	2.163	2.936	3.554
Seedlings and hauling of seedpieces			7.081				
Fertilizer	1.697	1.697	2.122	2.122	1.697	1.697	1.697
Total Costs	**25.730**	**25.730**	**21.803**	**18.003**	**19.848**	**22.116**	**25.730**
Fiber	57.938	57.938	0	23.175	34.763	46.350	57.938
Outer leaf sheet	4.023	4.023	0	1.612	2.415	3.219	4.022
Total Revenues	**61.961**	**61.961**	**0**	**24.787**	**37.178**	**49.569**	**61.960**
Cash Flow	**36.231**	**36.231**	**-21.803**	**6.784**	**17.330**	**27.453**	**36.230**
Discounted Cash Flow	**8.105**	**7.491**	**-4.166**	**1.198**	**2.829**	**4.141**	**5.051**

NPV: PHP 283.485

Appendix B

Acacia Cash flow table (1/2)

Year	0	1	2	3	4	5	6	7	8	9	10	11	12
Pruned logs (100m3/ha)	0	0	0	0	0	0	0	0	0	0	0	0	238.397
Branched logs (150m3/ha)	0	0	0	0	0	0	0	0	0	0	0	0	229.883
Pulp logs (50m3/ha)	0	0	0	0	0	0	0	0	0	0	0	0	102.170
Pulp log thinnings	0	0	0	0	0	0	136.227	0	0	0	0	0	0
Total Revenues	**0**	**0**	**0**	**0**	**0**	**0**	**136.227**	**0**	**0**	**0**	**0**	**0**	**570.450**
Seedling production	2.270	0	0	0	0	0	0	0	0	0	0	0	0
Access and fire ponds	689	0	0	0	0	0	0	0	0	0	0	0	0
Land preparation-burning	344	0	0	0	0	0	0	0	0	0	0	0	0
Land preparation-hole digging	2.893	0	0	0	0	0	0	0	0	0	0	0	0
Land preparation-back filling	3.031	0	0	0	0	0	0	0	0	0	0	0	0
Pest control	596	0	0	0	0	0	0	0	0	0	0	0	0
Land preparation - ground spray	3.122	0	0	0	0	0	0	0	0	0	0	0	0
Planting – production species	4.683	0	0	0	0	0	0	0	0	0	0	0	0
Fertilisation	1.703	2.696	0	0	0	0	0	0	0	0	0	0	0
Fertilisation	1.561	2.696	0	0	0	0	0	0	0	0	0	0	0
Strip spraying	1.703	1.703	0	0	0	0	0	0	0	0	0	0	0
Blanking (if required)	689	0	0	0	0	0	0	0	0	0	0	0	0
Form prune	0	331	0	0	0	0	0	0	0	0	0	0	0
Second prune	0	0	496	0	0	0	0	0	0	0	0	0	0
Thin to waste (300 sph)	0	0	0	689	0	0	0	0	0	0	0	0	0
Protection	710	710	710	710	710	710	710	710	710	710	710	710	710
Logging and loading	0	0	0	0	0	0	33.065	0	0	0	0	0	105.807
Cartage	0	0	0	0	0	0	19.839	0	0	0	0	0	79.355
Roading and skid formation	0	0	0	0	0	0	6.811	0	0	0	0	0	13.623
Sales commission/ management	0	0	0	0	0	0	6.130	0	0	0	0	0	20.434
Total Costs	**23.993**	**8.135**	**1.205**	**1.398**	**710**	**710**	**66.555**	**710**	**710**	**710**	**710**	**710**	**219.929**
Cash flow	-23.993	-8.135	-1.205	-1.398	-710	-710	69.672	-710	-710	-710	-710	-710	350.521
Discounted Cash flow	**-23.993**	**-7.519**	**-1.030**	**-1.104**	**-518**	**-478**	**43.421**	**-409**	**-378**	**-349**	**-323**	**-298**	**136.140**

Acacia Cash flow table (2/2)

13	14	15	16	17	18	19	20	21	22	23	24	25
0	0	0	0	0	0	0	0	0	0	0	0	238.397
0	0	0	0	0	0	0	0	0	0	0	0	229.883
0	0	0	0	0	0	0	0	0	0	0	0	102.170
0	0	0	0	0	0	136.227	0	0	0	0	0	0
0	**0**	**0**	**0**	**0**	**0**	**136.227**	**0**	**0**	**0**	**0**	**0**	**570.450**
2.270	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
2.893	0	0	0	0	0	0	0	0	0	0	0	0
3.031	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
4.683	0	0	0	0	0	0	0	0	0	0	0	0
1.703	2.696	0	0	0	0	0	0	0	0	0	0	0
1.561	2.696	0	0	0	0	0	0	0	0	0	0	0
1.703	1.703	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	331	0	0	0	0	0	0	0	0	0	0	0
0	0	496	0	0	0	0	0	0	0	0	0	0
0	0	0	689	0	0	0	0	0	0	0	0	0
710	710	710	710	710	710	710	710	710	710	710	710	710
0	0	0	0	0	0	33.065	0	0	0	0	0	105.807
0	0	0	0	0	0	19.839	0	0	0	0	0	81.736
0	0	0	0	0	0	6.811	0	0	0	0	0	13.623
0	0	0	0	0	0	6.130	0	0	0	0	0	20.434
18.553	**8.135**	**1.205**	**1.398**	**710**	**710**	**66.555**	**710**	**710**	**710**	**710**	**710**	**222.309**
-18.553	-8.135	-1.205	-1.398	-710	-710	69.672	-710	-710	-710	-710	-710	348.140
-6.660	**-2.699**	**-370**	**-396**	**-186**	**-172**	**15.586**	**-147**	**-136**	**-125**	**-116**	**-107**	**48.537**

NPV: 196.173 PhP

Appendix C

RF-Projection Cash flow table (1/3)

Years	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
A)RFtrees									
1. seedlings									
slowgr, sundemanding	225	23							
fastgr., sundemanding	3.064	306							
slowgr., shadedem.	0	0	0	282	30	0	0	0	0
fastgr., shadedem.	0	0	0	2.591	263	0	0	0	0
Fruit trees	0	0	0	2.929	293	0	0	0	0
Seedling-costs	3.290	329	0	5.803	586	0	0	0	0
2. Labor									
Family l.	0	0	0	0	0	0	0	0	0
Hired l.	20.907	96.607	77.208	44.114	17.566	48.430	43.874	41.790	41.790
B) intercrops									
Family labor	0	0	0	0	0	0	0	0	0
Hired labor	0	1.465	1.465	1.465	1.465	1.972	2.480	2.480	2.480
Total labor cost	20.907	98.072	78.673	45.579	19.031	50.402	46.354	44.270	44.270
Total family labor									
Total hired labor	20.907	98.072	78.673	45.579	19.031	50.402	46.354	44.270	44.270
Total Costs	**24.197**	**98.401**	**78.673**	**51.381**	**19.617**	**50.402**	**46.354**	**44.270**	**44.270**
A)RF-trees									
1. seedlings									
slow-gr, sun-demanding	0	0	0	0	0	0	0	0	0
lumber	0	0	0	0	0	0	0	0	0
fast-gr., sun-demanding	0	0	0	0	0	0	0	0	0
firewood	0	0	0	326	32	2.836	281	0	0
lumber	0	0	0	0	0	0	0	0	0
slow-gr., shade-dem.	0	0	0	0	0	0	0	0	0
poles	0	0	0	0	0	0	0	0	0
fast-gr., shade-dem.	0	0	0	0	0	0	0	0	0
poles	0	0	0	0	0	0	0	0	0
lumber	0	0	0	0	0	0	0	0	0
Fruit trees	0	0	0	0	0	0	0	0	0
Fruits	0	0	0	0	0	0	0	0	0
Poles	0	0	0	0	0	0	0	0	0
Revenues RF-trees	0	0	0	326	32	2.836	281	0	0
B. Intercorps:									
Banana	0	6.760	5.633	3.755	3.755	3.755	3.755	3.755	3.755
Pineapple	0	10.816	30.043	36.052	36.052	36.052	36.052	36.052	36.052
Other Fruits	0	6.009	6.009	6.009	6.009	6.009	6.009	6.009	6.009
Tacudo	0	7.210	7.210	7.210	10.816	14.421	18.026	18.026	18.026
Camote	0	11.266	7.323	5.633	5.633	5.633	5.633	5.633	5.633
Abaca	0	6.384	6.384	6.384	6.384	8.938	11.492	11.492	11.492
Revenues Intercrops	0	48.445	62.603	65.044	68.649	74.808	80.966	80.966	80.966
Total Revenues	**0**	**48.445**	**62.603**	**65.370**	**68.680**	**77.644**	**81.247**	**80.966**	**80.966**
Cash Flow	-24.197	-49.956	-16.070	13.988	49.064	27.242	34.894	36.696	36.696
Discounted Cash Flow	**-24.197**	**-46.170**	**-13.727**	**11.043**	**35.797**	**18.370**	**21.746**	**21.136**	**19.535**

RF-Projection Cash flow table (2/3)

9	10	11	12	13	14	15	16	17	18
0	0	0	0	0	0	0	0	0	0
0	0	0	0	138	138	138	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	138	138	138	0	0	0
0	0	0	0	0	0	0	0	0	0
41.790	41.790	41.790	41.790	280.351	66.519	43.671	43.548	44.133	52.921
0	0	0	0	0	0	0	0	0	0
2.480	2.480	2.480	2.480	2.480	2.480	2.480	2.480	2.480	2.480
44.270	44.270	44.270	44.270	282.831	68.999	46.151	46.028	46.614	55.401
44.270	44.270	44.270	44.270	282.831	68.999	46.151	46.028	46.614	55.401
44.270	**44.270**	**44.270**	**44.270**	**282.969**	**69.137**	**46.289**	**46.028**	**46.614**	**55.401**
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	1.961.897	193.768	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	3.347	4.407	5.659	7.111	8.773	10.653
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	3.245	6.730	11.837	15.442	17.305	17.425	17.425	39.327
0	0	0	0	0	0	0	0	0	0
0	0	3.245	6.730	1.977.081	213.618	22.964	24.536	26.198	49.980
3.755	3.755	3.755	3.755	3.755	3.755	3.755	3.755	3.755	3.755
36.052	36.052	36.052	36.052	36.052	36.052	36.052	36.052	36.052	36.052
6.009	6.009	6.009	6.009	6.009	6.009	6.009	6.009	6.009	6.009
18.026	18.026	18.026	18.026	18.026	18.026	18.026	18.026	18.026	18.026
5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633	5.633
11.492	11.492	11.492	11.492	11.492	11.492	11.492	11.492	11.492	11.492
80.966	80.966	80.966	80.966	80.966	80.966	80.966	80.966	80.966	80.966
80.966	80.966	84.211	87.696	2.058.047	294.584	103.930	105.503	107.164	130.946
36.696	36.696	39.941	43.426	1.775.077	225.447	57.641	59.475	60.551	75.545
18.795	**18.054**	**16.686**	**16.785**	**16.866**	**637.181**	**74.793**	**17.673**	**16.854**	**15.858**

RF-Projection Cash flow table (3/3)

Years	19	20	21	22	23	24	25
A)RFtrees							
1. seedlings							
slowgr, sundemanding							
fastgr., sundemanding							
slowgr., shadedem.	0	0	0	0	0	0	0
fastgr., shadedem.	0	0	0	0	0	0	0
Fruit trees	0	0	0	0	0	0	0
Seedling-costs	0	0	0	0	0	0	0
2. Labor							
Family l.	0	0	0	0	0	0	0
Hired l.	53.214	53.214	54.093	54.093	55.134	56.013	133.605
B) intercrops							
Family labor	0	0	0	0	0	0	0
Hired labor	2.480	2.480	2.480	2.480	2.480	2.480	2.480
TOTAL labor cost	55.694	55.694	56.573	56.573	57.614	58.493	136.085
TOTAL family labor							
TOTAL hired labor	55.694	55.694	56.573	56.573	57.614	58.493	136.085
Total Costs	**55.694**	**55.694**	**56.573**	**56.573**	**57.614**	**58.493**	**136.085**
A)RF-trees							
1. seedlings							
slow-gr, sun-demanding	0	0	0	0	0	0	0
lumber	0	0	0	0	0	0	151.132
fast-gr., sun-demanding	0	0	0	0	0	0	0
firewood	0	0	0	0	0	0	0
lumber	0	0	0	0	0	0	0
slow-gr., shade-dem.	0	0	0	0	0	0	0
poles	0	0	0	0	0	0	34.081
fast-gr., shade-dem.	0	0	0	0	0	0	0
poles	12.758	15.095	17.670	20.486	26.527	29.845	47.757
lumber	0	0	0	0	0	0	220.715
Fruit trees	0	0	0	0	0	0	0
Fruits	62.850	97.325	125.310	138.154	138.965	138.965	138.965
Poles	0	0	0	0	0	0	19.551
Revenues RF-trees	75.608	112.420	142.980	158.640	165.492	168.810	612.201
B. Intercorps:							
Banana	3.755	3.755	3.755	3.755	3.755	3.755	3.755
Pineapple	36.052	36.052	36.052	36.052	36.052	36.052	36.052
Other Fruits	6.009	6.009	6.009	6.009	6.009	6.009	6.009
Tacudo	18.026	18.026	18.026	18.026	18.026	18.026	18.026
Camote	5.633	5.633	5.633	5.633	5.633	5.633	5.633
Abaca	11.492	11.492	11.492	11.492	11.492	11.492	11.492
Revenues Intercrops	80.966	80.966	80.966	80.966	80.966	80.966	80.966
Total Revenues	**156.575**	**193.387**	**223.947**	**239.607**	**246.458**	**249.776**	**693.167**
Cash Flow	**100.881**	**137.693**	**167.374**	**183.034**	**188.844**	**191.284**	**557.082**
Discounted Cash Flow	**22.568**	**28.469**	**31.983**	**32.324**	**30.823**	**28.855**	**77.667**

NPV: 1.145.260 PhP

Appendix D

Cienda Cash Flow Table (1/6)

The following Cash flow describes the costs and revenues for the "representative" site *Cienda.* Note that the Cash flows are calculated on the basis of the respective stand size (see 4.22, Table 3). Costs and revenues (see 5.53, Table 10), discounted costs and benefits (see 6.2, Table 16) and finally NPV and annuity (see 7, Table 17) in the report are given on a one hectare basis.

Year	0	1	2	3	4	5	6	7
COSTS								
Brushing	11417							
Lay-outing	14842							
Staking	24737							
Hauling	9895							
Digging	24737							
Planting	14842							
Fruit tress	112991	12045	7337					
Forest trees	18454	6817	4188					
Sweet Potato	888							
Peanuts		3444						
Taro	1586							
Vegetables (seeds)	2299							
Ginger		2066						
Pruning / Thinning / Brushing	15984	47612	55348	44376	29338	17177	10695	10823
Replacement replanting	5328	9258	4610					
Climax								
Fuelwood								
Poles								
Lumber								
Pioneer								
Fuelwood								
Poles								
Lumber								
Unidentified Species								
Fuelwood								
Fruits								
Lansones								
Mangosteen								
Rambutan								
Guava								
Rattan								
Root Crops	904							
Peanut and Ginger		1719						
Vegetables	2488							
Pineapple			206	64	59	78	26	25
Additional Input								
Fertiliser	297	259						
Barbed wire	1421							
Total costs	**263107**	**83220**	**71689**	**44440**	**29396**	**17255**	**10721**	**10849**

Cienda Cash Flow Table (2/6)

Years	0	1	2	3	4	5	6	7
Revenues								
Timber								
Climax								
Fuelwood								
Poles								
Lumber								
Pioneer								
Fuelwood				320	410	167	468	2210
Poles								
Lumber								
Unidentified Species								
Fuelwood								
Fruits								
Lansones								
Mangosteen								
Rambutan								
Guava								
Marang				384	410	500	364	476
Intercrops								
Rattan								
Sweet Potatoes	3806							
Vegetables	5743							
Peanut		3720						
Taro	396							
Pineapple			1715	833	527	111	104	51
Ginger		4822						
Total Revenues	**9945**	**8541**	**1715**	**1537**	**1348**	**778**	**936**	**2736**
Cash Flow	**-253162**	**-74679**	**-69974**	**-42902**	**-28048**	**-16477**	**-9784**	**-8112**
Discounted Cash Flow	**-253162**	**-69019**	**-59770**	**-33869**	**-20464**	**-11111**	**-6098**	**-4672**

Cienda Cash Flow Table (3/6)

Year	8	9	10	11	12	13	14	15	16	17
COSTS										
Brushing										
Lay-outing										
Staking										
Hauling										
Digging										
Planting										
Fruit tress										
Forest trees										
Sweet Potato										
Peanuts										
Taro										
Vegetables (seeds)										
Ginger										
Pruning / Thinning / Brushing	971	971	971	971	971	971	971	971	971	971
Replacement replanting										
Climax										
Fuelwood			1121					1901		
Poles			1561					6178		
Lumber										
Pioneer										
Fuelwood			5937					11278		
Poles			11578					0		
Lumber			21968					156481		
Unidentified Species										
Fuelwood			467					1109		
Fruits										
Lansones		0	0	0	0	0	0	0	26340	26340
Mangosteen		0	0	0	0	0	0	28047	28047	28047
Rambutan		0	0	0	0	2796	5591	8387	11182	13978
Guava		0	0	0	0	93	186	280	373	466
Rattan				18	18	18	18	18	18	18
Root Crops										
Peanut and Ginger										
Vegetables										
Pineapple										
Additional Input										
Fertilizer										
Barbed wire										
Total costs	**971**	**971**	**43602**	**989**	**989**	**3878**	**6767**	**214649**	**66931**	**69820**

Cienda Cash Flow Table (4/6)

Year	8	9	10	11	12	13	14	15	16	17
Revenues										
Timber										
Climax										
Fuelwood			1414					2399		
Poles			2213					8759		
Lumber										
Pioneer										
Fuelwood			7492					14232		
Poles			16416					0		
Lumber			71247					507507		
Unidentified Species										
Fuelwood			589					1399		
Fruits		0	0	0	0	0	0	0	87800	87800
Lansones		0	0	0	0	0	0	93491	93491	93491
Mangosteen		0	0	0	0	9319	18637	27956	37275	46594
Rambutan		0	0	0	0	311	621	932	1242	1553
Guava										
Marang										
Intercrops										
Rattan				61	61	61	61	61	61	61
Sweet Potatoes										
Vegetables										
Peanut										
Taro										
Pineapple										
Ginger										
Total revenues	**0**	**0**	**99372**	**61**	**61**	**9690**	**19320**	**656736**	**219869**	**229498**
Cash Flow	**-971**	**-971**	**55770**	**-928**	**-928**	**5813**	**12553**	**442087**	**152938**	**159678**
Discounted Cash Flow	-517	-478	25359	-390	-360	2087	4165	135550	43339	41820

Cienda Cash Flow Table (5/6)

Year	18	19	20	21	22	23	24	25
COSTS								
Brushing								
Lay-outing								
Staking								
Hauling								
Digging								
Planting								
Fruit tress								
Forest trees								
Sweet Potato								
Peanuts								
Taro								
Vegetables (seeds)								
Ginger								
Pruning / Thinning / Brushing	971	971	971	971	971	971	971	971
Replacement replanting								
Climax								
Fuelwood			2153					4330
Poles			6997					0
Lumber								93456
Pioneer								
Fuelwood			12774					32114
Poles			0					0
Lumber			177243					693133
Unidentified Species								
Fuelwood			1256					4210
Fruits								
Lansones	26340	26340	26340	26340	26340	26340	26340	26340
Mangosteen	28047	28047	28047	28047	28047	28047	28047	28047
Rambutan	13978	13978	13978	13978	13978	13978	13978	13978
Guava	466	466	466	466	466	466	466	466
Rattan	18	18	18	18	18	18	18	18
Root Crops								
Peanut and Ginger								
Vegetables								
Pineapple								
Additonal Input								
Fertilizer								
Barbed wire								
Total costs	**69820**	**69820**	**270243**	**69820**	**69820**	**69820**	**69820**	**897063**

Cienda Cash Flow Table (6/6)

Year	18	19	20	21	22	23	24	25
Revenues								
Timber								
Climax								
Fuelwood			2717					5464
Poles			9921					0
Lumber								303101
Pioneer								
Fuelwood			16120					40525
Poles			0					0
Lumber			574841					2247999
Unidentified Species								
Fuelwood			1585					5312
Fruits								
Lansones	87800	87800	87800	87800	87800	87800	87800	87800
Mangosteen	93491	93491	93491	93491	93491	93491	93491	93491
Rambutan	46594	46594	46594	46594	46594	46594	46594	46594
Guava	1553	1553	1553	1553	1553	1553	1553	1553
Marang								
Intercrops								
Rattan	61	61	61	61	61	61	61	61
Sweet Potatoes								
Vegetables								
Peanut								
Taro								
Pineapple								
Ginger								
Total revenues	**229498**	**229498**	**834682**	**229498**	**229498**	**229498**	**229498**	**2831899**
Cash Flow	**159678**	**159678**	**564439**	**159678**	**159678**	**159678**	**159678**	**1934836**
Discounted Cash Flow	38650	35721	116700	30512	28200	26063	24087	269751

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