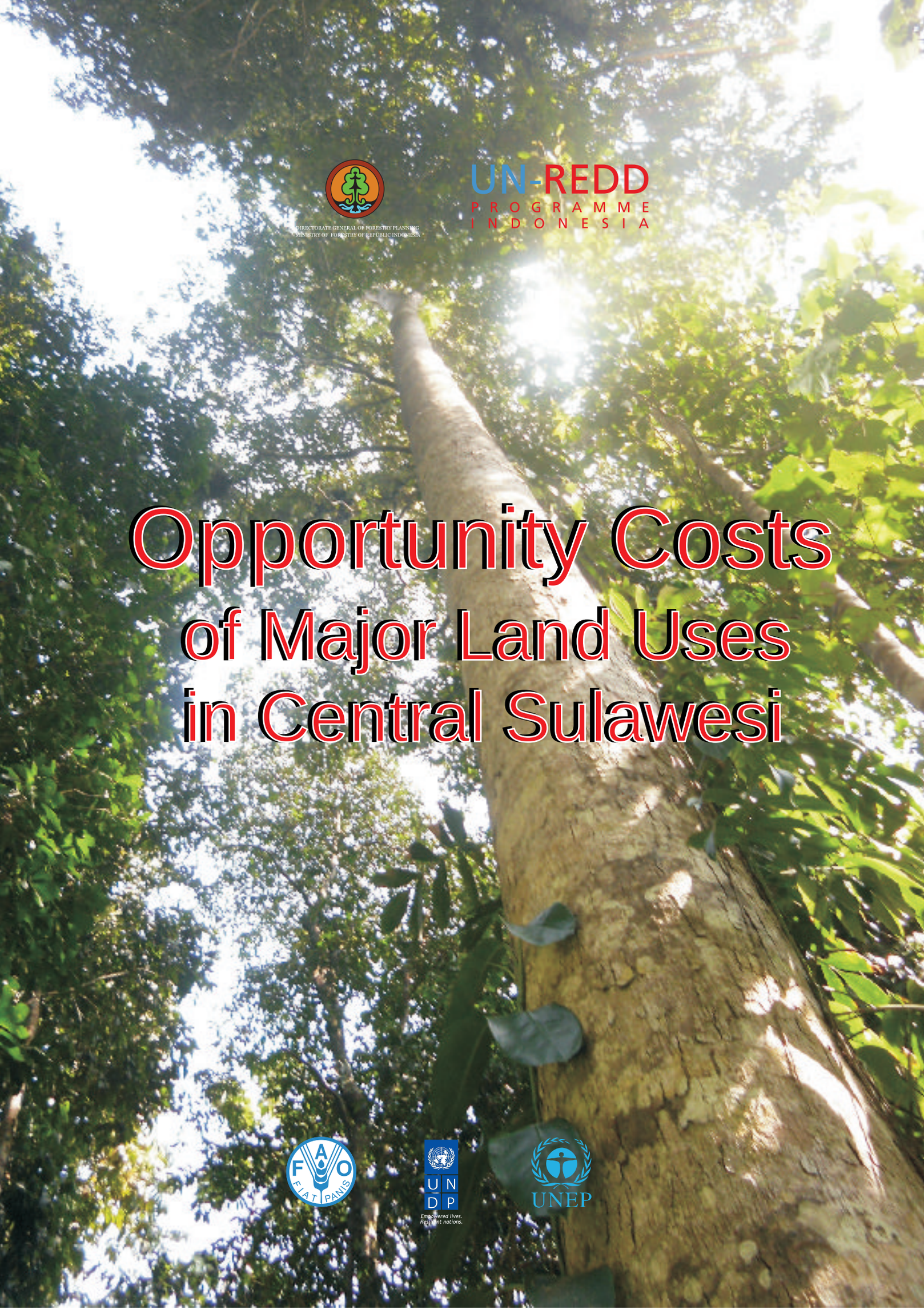

DIRECTORATE GENERAL OF FORESTRY PLANNING
MINISTRY OF FORESTRY OF REPUBLIC INDONESIA

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Opportunity Costs of Major Land Uses in Central Sulawesi

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Opportunity Costs of Major Land Uses in Central Sulawesi

OPPORTUNITY COSTS OF MAJOR LAND USES
IN CENTRAL SULAWESI

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Abbreviations

APL	Areal Penggunaan Lain - Land for other purposes
BAPPENAS	Badan Perencanaandan Pembangunan Nasional - National Planning Agency
BPN	Bapan Pertanahan Nasional - National Land Agency
BPS	Badan Pusat Statistik - Center for Statistics Bureau
Ditjenplan	Directorate General of Planology, Ministry of Forestry
GDP	Gross Domestic Product
GDRP	Gross Domestic Regional Bruto
HPH	Hak Pengusahaan Hutan - Logging Concessionaries now called IUPHHK
HTR	Hutan Tanaman Rakyat - Community Timber Plantation
ICRAF	International Centre Research for Agroforestry - World Agroforestry Centre
IFCA	Indonesia Forest Carbon Alliance
IPCC	Intergovernmental Panel on Climate Change
IPK	Izin Pemanfaatan Kayu - Timber Utilization License in APL areas
IUPHHK-HA or HPH	Izin Usaha Pemanfaatan Hasil Hutan Kayudalam Hutan Alam - Logging concession in forest production areas
IUPHHK-HT or HTI	Izin Usaha Pemanfaatan Hasil Hutan Kayudalam Hutan Tanaman - Timber Plantation concession in forest production areas
MoFor	Ministry of Forestry
MRV	Measurement, Reporting and Verifying
NPV	Net Present Value
REDD+	Reducing emissions from deforestation and forest degradation and conservation of carbon

SKSHH	Surat Keterangan Sahnya Hasil Hutan - Licenses to transport logs
TGHK	Tata Guna Hutan Kesepakatan - Forest Land Use by Consensus
USD or US$	United States Dollars

1. Introduction

It is widely known that the forestry sector plays an important role in climate change regime. The world's forest ecosystems hold more than half of all terrestrial carbon (Smith et al., 1993). Further, IPCC (2007) indicated that forest clearance and forest degradation have contributed to approximately 18 percent of the total anthropogenic carbon emissions, which represents approximately 1.6 billion tonnes of carbon annually released in the atmosphere. About 75 percent of forest degradation occurs in developing countries, which are particularly important because of the demographic, economic, and social changes that continue to exert extensive pressures on forest cover (Achard et al., 2002). This sector has not been fully addressed in the Kyoto Protocol, since it was considered not offering enough guarantees to avoid leakage and risk to induce a new generation of "hot air" (Santilli, 2003; Santilli, 2005). Since then, many reports, such as the Stern Review argues that reducing emission from deforestation in developing country should become priority for future mitigation strategies. At the COP 13 in 2007 held in Bali, the parties adopted two decisions to address deforestation and forest degradation in developing countries, now well known as the REDD+ mechanism.

The REDD+ mechanism is based on the premise that financial incentives can be given to developing countries that put in place new policies and measures to reduce emissions from deforestation and forest degradation. To achieve the targets set for reducing emissions from deforestation and forest degradation, payments have to cover the costs associated with avoiding deforestation activities (Kindermann*et al.* 2008; Peskett*et al.*, 2008; Tacconi*et al.*, 2009a).

Information regarding REDD+ costs is highly relevant, particularly for investors to assess the allocation of investments and returns on investments (in terms of the amount of reduced emissions); for policy-makers to formulate appropriate strategies, policies and measures to reduce GHG emissions. Information on REDD+ costs could also be used by local government as one of the indicators for prioritizing activities and for designing financing mechanisms of the local action plan (RAD-GRK); and for land owners to understand the likely impacts of the REDD+ programme on their livelihoods. In short, information on REDD+ costs estimation can tell whether a particular mitigation option would be more attractive (or more financially feasible) compared to other alternatives, and indicate the minimum price for selling carbon from a particular activity related to the forestry sector.

To estimate REDD+ costs, various approaches have been developed. The distinctions of these approaches are discussed in the next section. Based on the publication by Myers (2007), REDD+ activities have substantial carbon benefits with low initial carbon prices at US$10/tC (US$2.7 per tCO_2) or less. Exceptions were pointed out by Enkvist et al. (2007) who claimed that abatement costs of deforestation by 50 percent in Africa and 75% in Latin America would cost US$183.5/tC (US$50/tCO_2) and abate about 3 $GtCO_2$ emissions. These costs are even higher for Asia's forests because of land scarcity and higher opportunity costs. These various studies have suggested that the economics of REDD+ would depend not only on the types of alternative economic activity but their geographical location and comparative advantage. For those reasons, accurate estimations of REDD+ costs are highly needed. The present study will estimate the foreseen benefits from the REDD+ activities in the province of Central Sulawesi, which is a pilot area of the UN-REDD Programme in Indonesia.

1.1 Objectives

The objectives of this study are:

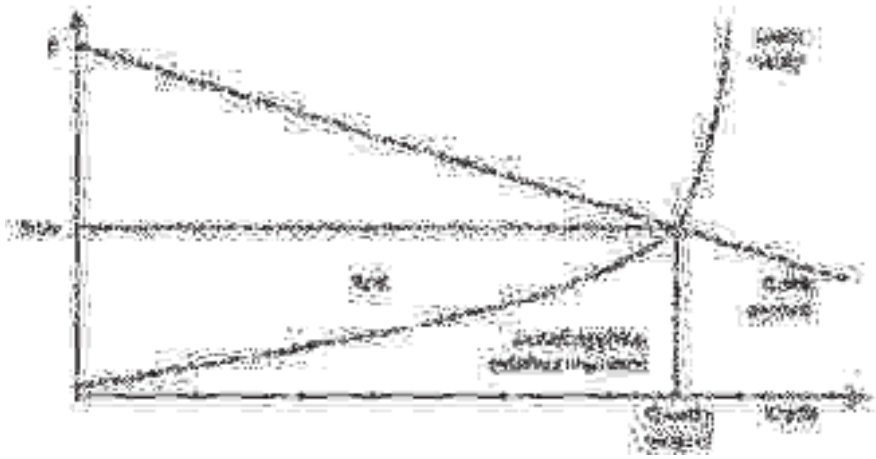
1) To estimate the opportunity cost of reducing emissions from deforestation and degradation.

2) To identify mitigation options related to forestry and land-based sectors, and associated costs.

1.2 Introduction to Opportunity Costs

The calculation of the opportunity costs of REDD+ is based on the concept of the supply curve (marginal cost curve), which suggests that there is no single cost-value per ton carbon but rather a range of costs depending on the quantity of possible reduction in forest emissions (Wertz-Kanounnikoff, 2008; Lubowski, 2008). Further, Lubowski (2008: pp.2) illustrated that "the cost curve slopes upwards, showing that for small emission reductions, costs can be kept low by protecting just the lowest-cost lands; with greater reductions, the added incremental or marginal cost rises as protection must extended to higher-cost lands."

FIGURE 1. MARGINAL COST CURVE THEORY



Several models have been developed to estimate REDD+ opportunity costs and can be categorized into three types: local-empirical models; global-empirical approaches; and global simulation models (See Table 1).

In general, global simulation models indicate far higher opportunity costs than empirical studies.The realistic value most likely lies between these extremes (the local empirical at the lower end and global simulation model at the higher end) (Wertz-Kanounnikoff; 2008). The more accurate the analysis, the better the information. Accuracy analysis however depends on the availability of resources and time, national context of land use and the potential benefits of improved estimates.

TABLE 1. DIFFERENT MODELS TO ESTIMATE
THE ABATEMENT COST RELATED TO LAND BASED NAMAS

Local-empirical Models	Global Simulation Models	Global-empirical Approaches
• Borner and Wunder (2008) - 2 states of the Brazilian Amazon	• The Dynamic Integrated Model of Forestry and Alternative Land Use (DIMA)	Grieg-Gran (2006) for the Stern Review - 8 main tropical forest nations (Brazil, Bolivia, Cameroon, Democratic Republic of Congo, Ghana, Indonesia, Malaysia and PNG), cumulatively account for 46% of global deforestation
• Swallow et al. (2007)[1] - 3 sites in Indonesia, 1 in Peru and 1 in Cameroon	• The generalized Comprehensive Mitigation Assessment Process Model (GCOMAP)	
• Nepstadet al. (2007) - Brazilian Amazon region	• The Global Timber Model (GTM)	

Source: Adapted from Boucher (2008); Kinderman et al. (2008); Myers (2007) and Wertz-Kanounnikoff (2008)

Box 1. REDD+ Costs

The costs of REDD+ fall into two categories (Wertz-Kanounniko-ff, 2008):

1. The '***opportunity costs***', or the forgone profits from alternative land uses such as logging, plantations, or food crops, that is related to the minimum price to be paid for REDD+ services.
2. The ***'transaction costs'***, which encompass all costs associated with establishing and running the scheme (government transaction costs), and the costs individual landowners have to bear in order to participate in the program (private transaction costs). It includes costs for measurement, monitoring, capacity building, planning, brokerage, verification, certification, insurance, etc.

However, some literatures also distinguish **'implementation costs**' as an additional cost category. Implementation costs cover the costs of implementing measures to reduce emissions, as distinct from transaction costs, which are those costs associated with measuring, reporting, verifying, and distributing benefits (Pagiola and Bosquet, 2009).

Forests have four roles for people: (1) provide with basic goods for subsistence, such as fuelwood, medicines, bush meat and fruits; (2) provide goods to be sold such as wood products, arts and crafts; (3) source of income from employment in forest-related activities; (4) land for other uses and environmental services (FAO/DFID, 2001). Preserving forests means that only some of those benefits are generated by the land when used alternatively, for instance benefits from agricultural production and revenue from logged timber if the forest were to be converted into agricultural land. The opportunity cost of avoiding deforestation is the difference between the benefits provided by conserving the forest and those that would have been provided by alternative uses. Some literature indicates that opportunity costs would be the largest share of REDD+ costs (Boucher, 2008; Pagiola and Bosquet, 2009).

In some cases such as illegal logging, the calculation of opportunity costs might not be the appropriate approach to estimated REDD+ costs. The implementation cost for enforcing the law forbidding illegal logging in a given area would be instead more appropriate. That being said, this study only focuses on the estimation of opportunity costs. The present study does not estimate the indirect costs from activities (e.g. the socio-economic benefits of conserving forests), since it is planned that another study under the UN-REDD Programme in Indonesia will cover these issues.

2. Study Area Profile: Central Sulawesi Province

2.1 General Overview

Central Sulawesi Province is situated between 2°22' north latitude - 3°48' south latitude and 119°22'- 124°22' east longitude. It is the largest province of Sulawesi Island, covering 68,033 km^2 of land and 189,480 km^2 of sea. About 64.60 percent of the land area of the province is classified as forest zone, and more than 70% of the Province still has forest cover (Ditjenplan, 2011).

TABLE 2. TOPOGRAPHY OF CENTRAL SULAWESI

Topography	Percentage of Area (%)
Slope (Degree)	
0-3°	11.8
3-15°	8.9
15-40°	19.9
40°	59.9
Elevation (m)	
Altitude 0 - 100	11.8
Altitude 101 - 500	27.2
Altitude 501 - 1000	26.7
Altitude 1001 up	25.9

Source: BPS, 2011

Central Sulawesi Province has the lowest rainfall in Indonesia, which average is 864 mm per year, with the highest rainfall in June about 123 mm, and the lowest in March about 12 mm. Temperatures range from 25 to 31° Celsius in the coastal plains down to 16

to 22° Celsius in mountainous regions, with humidity levels ranging between 71 and 76 percent. The region of the Central Sulawesi is dominated by hilly to mountainous topography. Based on the slope and elevation, the broken down terrain of Central Sulawesi is presented in Table 2. Given the fact that almost 60 percent of the region features a slope of 40° and above, vast areas of the region are less suitable for paddy fields or large-scale plantations such as palm oil. The cost induced by logging operations is also higher compared to flat topographies, since it requires extra labor and equipment.

Administratively, Central Sulawesi Province consists of ten districts and one city: Banggai, Banggai Islands, Buol, Donggala, Morowali, Parigi Mountong, Poso, Tojo Una-Una, Toli-Toli, Sigi, and Palu. In 2010, the average population density in Central Sulawesi is 39 people per square km, with a population growth rate of 1.95 percent between 2000 and 2010.

In 2010, the Gross Domestic Regional Product (GDRP)[2] per capita of Central Sulawesi Province was about IDR 6.6 billion compared to the national GDP of IDR 9.7 billion; and more than 60 percent of the GRDP per capita is spent for consumption (BPS, 2011). The agricultural sector[3] is vital for the economy of Central Sulawesi, contributing to almost 40 percent of the total regional economy in 2010 (see Figure 2). The sector also provides employment for over 600,000 people (or almost 60 percent of the total population aged 15 and over).

Cocoa is the main agricultural commodity in Central Sulawesi. In 2010, export volume of cocoa beans was more than 109,000 representing a total value of US$297 million. In 2011, the mining sector, although representing a relatively small contribution to the regional economy (about 1.71 percent) grew by 35.16 percent (BAPPEDA, 2012). Central Sulawesi also has high potential for oil, gas, nickel, coal, chromites and marble, which may lead the mining sector to play a more important role in the future. Currently, logging companies (IUPHHK-HA or HPH) in Central Sulawesi are mostly

[2] GDRP by Constant Market Prices 2000

[3] Agricultural Sector as defined in BPS includes food crops, plantation, livestock, forestry and fisheries

FIGURE 2. GDRP OF CENTRAL SULAWESI BY SECTOR

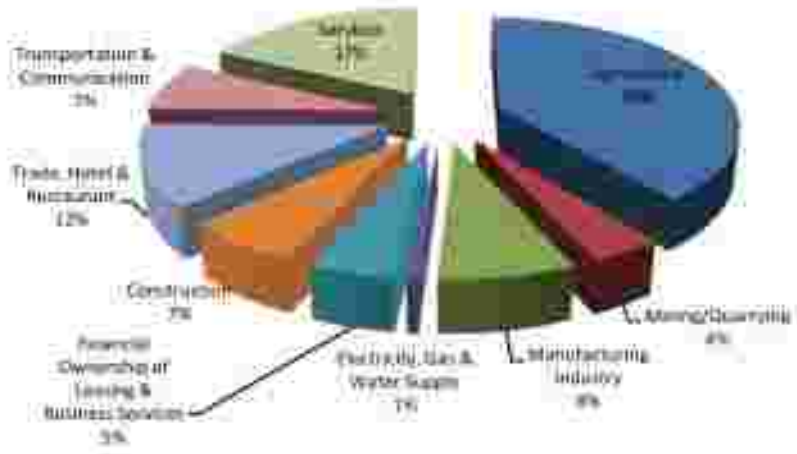


Figure 2. GDRP of Central Sulawesi by Sector

Source: BPS, 2011

inactive. Forest industry in Indonesia has been declining for almost two decades. Various reasons explain the situation: conflict with local community, high levies and charges by community and government including local and national level, inconsistency policy and regulation from local and national government that all are leading to high production costs. These conditions combined with the current market trend gives incentives to license holders to retain their licenses without actually pursuing logging activities. This passive strategy is the origin of a significant drop in revenue generated by the forestry sector.

Small logging concessions (IPK) and illegal logging continue to operate, as shown by the intensity of sawmill operations and volume of transported logs from Sulawesi to other regions (mainly Kalimantan and Surabaya), while official revenues to the local government from the forestry sector are rather low (Kasim, 2008). Additionally the study also shows that the number of licenses to transport logs (SKSHH) far exceeds permits issued to fell timber both from IPK and HPH. Nevertheless, from field observation, these activities in general are decreasing in recent years.

2.2 Forest and Land Use Systems

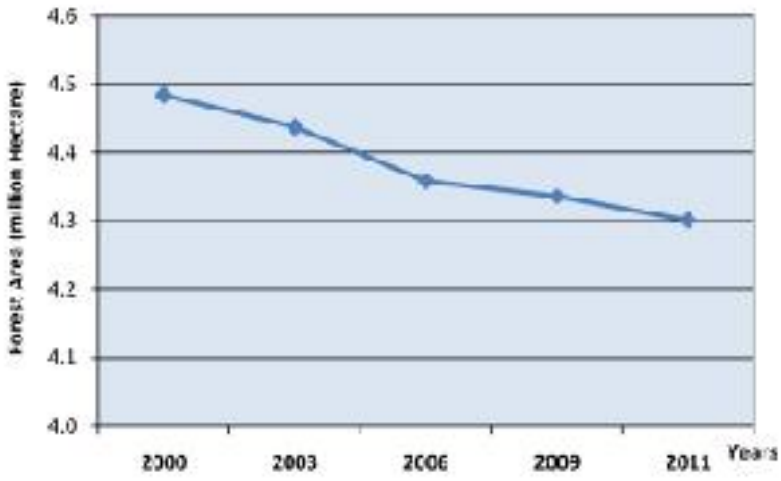
The total area of the forest zone in Central Sulawesi is about 4.4 million hectare or almost 65 percent of the total Central Sulawesi Province. The forest zone is defined as the total area of forest ecosystems determined by the government as permanent forest, legitimization of the forest zone is supported by boundary demarcation. Based on Forest Land Use by Consensus (Tata Guna Hutan Kesepakatan – TGHK[4]), forest land is classified by function: (1) protection forest; (2) conservation forest; (3) limited production forest; (4) production forest allocated mainly for commercial logging; and (5) conversion forest assigned to be converted for other land uses. Other areas outside forest zone are classified as Land for Other Purposes (APL) which covers 2.4 million hectare (or 35 percent of the total area). Although the extent of the forest zone has remained almost unchanged since the 1960s, forest cover in the region has considerably changed.

The deforestation rate in the period 2000-2011 was almost 46,000 hectare per year and in 2011, degraded areas in the Province amounted to more than 400,000 ha[5] (Ditjenplan, 2011). The underlying causes of deforestation in Central Sulawesi Province are mainly due to insufficient law enforcement, ineffective spatial planning, ineffective management of forest management units and a problematic tenure system; while the main drivers of deforestation and forest degradation in the region are forest conversion for plantation expansion, mining, illegal logging and forest fire.

[4] The map of forest land use planning that is resulted from the overlaying Forest Cover Map, Forest Area Designation Map and Provincial Spatial Planning Map. The map is commonly produced after long negotiation between several relevant ministries mainly Mofor, Ministry of Public Work, National Planning Agency and Provincial governments.

[5] Shrub, grassland and bare land

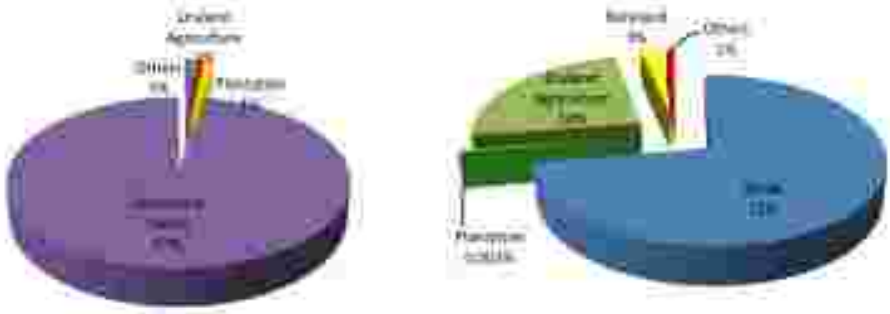
FIGURE 3. DEFORESTATION RATE IN CENTRAL SULAWESI 2000 – 2011



Source: Modified from Ditjenplan data (2011)

Compared to 2000, from the total 3.1 million hectare undisturbed forest 83 percent of the area are intact in 2011; while some 520,000 of undisturbed forest are classified as secondary forest in 2011. In 2011, more than 97,000 of secondary forest also converted into shrub and some 32,000 of secondary forest are converted into agricultural land. Figure 4 shows the land cover changes of undisturbed forest and secondary forest into another land class types.

FIGURE 4. LAND COVER CHANGES 2000–2011



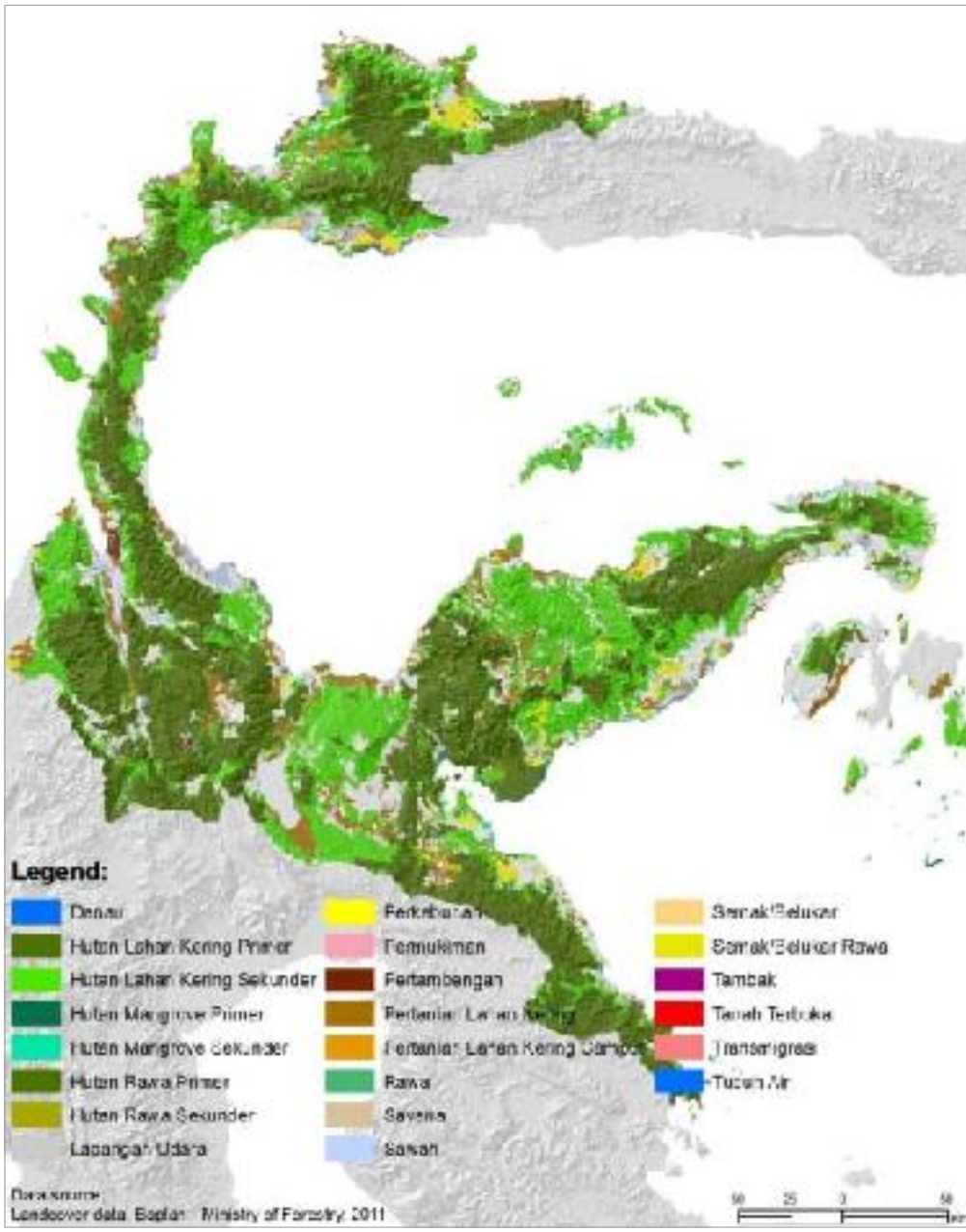
(a) Land cover changes in undisturbed forest

(b) Land cover changes in secondary forest

Source: Modified from Ditjenplan data (2011)

Figure 5 shows the land cover map of the Central Sulawesi Province in 2011 derived from spatial analysis. There are 22 classes of land cover type in Central Sulawesi, but for the purposes of this study only the main land uses are selected to be further analyzed.

FIGURE 5. LAND COVER MAP OF CENTRAL SULAWESI 2011



Source: Ditjenplan, MoFor (2011); Map layout is prepared by UNREDD

LEGEND

Danau	Lake	Perkebunan	Plantation	Sawah	Paddy field
Hutan lahan kering primer	Primary dryland forest	Pemukiman	Settlement	Semak/belukar	Bush/Shrub
Hutan lahan kering sekunder	Secondary dryland forest	Pertanian lahan kering	Dryland agricuture	Semak/belukar Rawa	Swamp Shrub
Hutan rawa primer	Primary swamp forest	Pertanian lahan kering campur	Dryland mixed agricuture	Tambak	Fish pond
Hutan rawa sekunder	Secondary swamp forest	Rawa	Swamp	Tanah terbuka	Bare land
Lapangan udara	Airport	Savana	Savanna	Transmigrasi	Transmigration area
				Tubuh air	Water body

Statistics for 2010, presented in Table 3, showed that only about 38 percent of the area of Central Sulawesi is classified as forest (BPS, 2011); whereas data from MoFor indicates that forest covers more than 70 percent of the region. The discrepancy might be due to different definition of forest used by BPN and Ministry of Forestry. Given the discrepancy, this study uses data from MoFor, since it is supported by the land cover maps as well as carbon stock data. Ideally the land classification framework should be consistent for any Ministries/Agencies and be compatible with the MRV system for forest and land based resources as well as for REDD+ mechanisms. In a vast country such as Indonesia, appropriate land use mapping is the greatest challenge to develop a robust MRV system.

TABLE 3. LAND COVER IN CENTRAL SULAWESI, 2010

Land Use Type	Size (Ha)*	Percentage (%)	Size (Ha)*	Size (Ha)*
Settlement	164,264	2.41	29,341	0.48
Paddy Field	154,412	2.27	103,817	1.70
Dryland Agriculture	673,057	9.89	433,425	7.10
Plantation	711,526	10.46	126,680	2.07
Agriculture Land (Agroforestry)	565,154	8.31	587,707	9.63
Mining	162,692	2.39	11,894	0.19
Forest	**2,609,697**	**38.36**	**4,306,752**	**70.54**
Primary Forest	n.a.	n.a.	2,554,789	41.85
Secondary Forest	n.a.	n.a.	1,751,963	28.70
Shrubs	244,673	3.60	363,928	5.96
Water body	83,120	1.22	66,790	1.09
Bareland	n.a.	n.a.	41,356	0.68
Grassland	n.a.	n.a.	30,890	0.51
Others/No Data	1,434,705	21.09	2,565	0.04
Total	**6,803,300**	**100.00**	**6,105,145**	**100.00**

Source:

* BPS, 2011 (based on data from Regional Office of the National Land Agency - BPN)

** Directorate of Forest Inventory and Monitoring, Ditjenplan, MoFor (2011)

3. Methodology

While in theory estimating opportunity costs is quite simple, it can be in practice difficult to generate reliable estimates. For this reason, multiple calculation series should be conducted and the iterative process of building assumptions often involve several cycles of discussion to build consensus. Primary and secondary data are used in this analysis. Spatial information and carbon stock data mainly come from databases of the Ministry of Forestry as well as other components of UN-REDD Programme in Indonesia. Data to construct farm budgets as the basis for profitability analysis mainly come from field assessment. The field assessment, which was conducted in February 2012, involved field observations, and in-depth interviews with local government agencies, as well as land owners and other stakeholders. A semi structured interview guide was used for in-depth interviews (see Appendix 1).

To get an overview of land use system in Central Sulawesi, relevant local government offices (SKPDs) have been interviewed. In addition, land owner/managers were interviewed to get detailed information on land management of selected land use type as well as their input and outputs. For each land use type, a group of three to five farmers were randomly selected. A questionnaire guides the discussion and the interview. For logging companies, detailed information was obtained from interviews with Dinas Kehutanan and APHI (*Indonesian Association* for *Forest Concession Holders*). In addition more details were obtained via official documents such RKU (Rencana Kerja Umumor Long-term Management Plan) and RKT (Rencana KerjaTahunan or Annual Work Plan). Information regarding large-scale palm oil plantations was based on interviews con-

ducted with several palm oil companies in Palu and completed by official management planning documents.

There are several steps in estimating opportunity costs:

- Characterization of land use systems and estimating carbon stocks of different types of land uses.
- Estimating associated profit of different main land use systems. Net present value of activity data, enterprises budget (including revenue, costs, establishment phase, operation phase, labour, etc.)
- Policies related to forest and land-based resources management

3.1 Characterization of Land Use Systems

Information on the extent of major land uses is derived from sequential analysis of spatial data sets. The characterization of land use systems mainly relies on land cover maps that come from the Directorate of Forest Resources Monitoring and Inventory, Ministry of Forestry. The terms "land cover" and "land use "are quite different. The term "***land cover"*** refers to the physical material at the surface of the earth e.g. tree cover, water body, grass, bare land; whereas the term "***land use"*** refers to utilization of land or human modification of the natural environment into planned or built environments e.g. agricultural fields, settlements, cocoa plantations, etc. (Dewi et al., 2010).

The land cover maps used in this study are produced by the Directorate of Forest Resources Monitoring and Inventory to monitor forest resources using remote sensing technologies every three years (data used in this study are from 2000, 2003, 2006, 2009, and 2011). The land cover maps are based on the visual interpretation of Landsat 7 ETM+, Landsat 5 TM and SPOT 4 images that is projected onto a thematic map, scale 1:250,000. The land cover maps distinguish 23 land cover classes. However, classification of land cover for areas outside the forest zone is less detailed compared to the area in the forest zone. For instance, 'plantation' is categorized as a single class, which could result in inaccurate estimates of carbon stocks as well as profitability of the land uses.

Consequently, for characterization of main land uses the information derived from land cover maps had also to be crossed checked with statistical data, information from field observations and in-depth interviews. The statistical data show the major land use systems and main agricultural commodities in Central Sulawesi, hence their significance in terms of the regional economy. The field observations coupled with in-depth interviews give detailed information regarding the management of specific land use types.

Information regarding carbon stocks is derived from data available at the Directorate of Forest Resources Monitoring and Inventory, Ministry of Forestry. The carbon stock data for forest areas mostly come from the 'National Forest Inventory' (NFI). In addition, carbon stock data for particular land uses such as cocoa and coconut plantation, and other agricultural systems, as presented in

Table 4, are derived from literature compiled under several studies (Bappenas Study, 2010; ICRAF Study, 2010). Currently, only the above ground carbon stock data are available. A recent research has published figures regarding below ground carbon (Houghton, 1999; Brown, 1997; Archard et al., 2004 and IPCC, 2006). However the numbers are still highly uncertain if applied for Indonesia forest and need further ground measurement for validation. For this reason, the present study does not take into account below ground carbon, although it could be quite significant, particularly for the peatland soil.

TABLE 4. ABOVE-GROUND BIOMASS
OF VARIOUS LAND USE SYSTEMS IN INDONESIA

Land Cover Type	Carbon Stock (tC per ha)	Reference/ Assumptions
Primary Forest	195.4	TSP/PSP NFI -MoFor
Secondary Forest	169.7	TSP/PSP NFI -MoFor
Primary Mangrove Forest	170	BAPPENAS Study, 2010
Primary Peat Forest	196	Based on IFCA Study (MoFor, 2008)
Secondary Mangrove Forest	120	Komiyama, 1998 in (BAPPENAS Study, 2010)
Secondary Peat Forest	155	Based on IFCA Study (MoFor, 2008)
Forest Plantation	100	Ditjenplan, MoFor
Shrub	15	Wasrin, 2000 in (BAPPENAS Study, 2010)
Swamp Shrub	15	Ditjenplan, MoFor
Agriculture Plantation	63	Rogi (2002); Palm et al. (2004); IPCC (2006)
Cocoa	29.3	Yuliasmara, 2008 in (ICRAF Study, 2010)
Coconut	30.7	FAO, 1997
Palm oil	40	ICRAF Study (2010)
Settlement	1	Ditjenplan, MoFor
Bare Land	0	Ditjenplan, MoFor
Grassland	4.5	Ditjenplan, MoFor
Annual Crop Agriculture	8	Ditjenplan, MoFor
Agriculture Land (agroforestry)	10	Ditjenplan, MoFor
Rice Field	5	Ditjenplan, MoFor
Pond	0	Ditjenplan, MoFor
Airport	0	Ditjenplan, MoFor
Transmigration	10	Combination settlement and agriculture land
Mining	0	Ditjenplan, MoFor
Swamp	0	Ditjenplan, MoFor
Water	0	Ditjenplan, MoFor

Source: Data are compiled from Directorate of Forest Resources Monitoring and Inventory, Ditjenplan, MoFor; BAPPENAS Study (Boer et al., 2010) and ICRAF Study (Dewi et al., 2010).

3.2 Estimating Associated Profit of Different Main Land Use Systems

Land use systems in Central Sulawesi are dominated by perennials and these involve long-term investment. The profitability is measured in the net present value (NPV) or present discounted values of revenue minus costs (fertilizer, tools, labor, management, etc.) over the analysis period that is 25 years. The 25-year analysis period was chosen since most of the major land uses in Central Sulawesi have a 25-year production cycle such as palm oil, cocoa and coconut beyond this 25-year cycle the production would considerably drop and the plantation should be re-established. In regards to logging activities, the license for IUPHHK-HA or HPH is 20 years and can be extended until 55 years. To achieve consistency and comparability, the study uses the 25-year period of analysis for all land use types. Hence, the analysis of paddy field is reiterated for 25 years.

Mathematically, it could be described as follows (Gittinger, 1982).

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

Where *Bt* is benefit at year t, *Ct* cost at year t, *t* is time denoting year and *i* is discount rate. An investment in land use activity unit over 25 years since its establishment is appraised as profitable if NPV is greater than 0. Conversely, an activity with NPV less than zero is 'unprofitable' by definition. At NPV d" 0, it would be more profitable to invest the land, labor and capital into other activities/ alternatives than to devote them to this activity.

In this study, farm budget analysis is employed to determine profits from different main land use systems, received by land owner/manager. The farm-budget model is the earliest optimizing tools to calculate net farm income for various land-use and technology mixes. The analyst made a priori assumptions about crop species and rotation patterns, prices of inputs and products, and production technology (Riebsame, et al., 1994). The use of farm

budget model served mainly to summarize important changes in land use practices and their effect on output. It provides a guide to the relative profitability of similar enterprises and an indication of the different management practices used. The initial results of the analysis show the competitiveness of a land use system compared to other alternatives. The main required data and information for this analysis are farm inputs or revenue and input costs that are all measured in actual market prices. In this study, the value of land for all land use systems is assumed to be zero, since it is considered the value of land is the function of profitability and the cost component of land acquisition, such as land permit for HPH already included in the farm budget calculation. Further, the study also does not include the salvage value since the discounted value of land systems at year 25 because it will be of negligible proportion compared to overall returns.

Private profitability calculation shows the competitiveness of agricultural systems at given current technologies, output values, import costs and policy transfers. The study does not analyze the social values that reflect efficiency. For this reason, the present study does not analyze divergence between private (reflecting actual market) & social prices (reflecting efficiency). Analyzing the divergence between private and social prices would be an important indicator for the impacts of government policy on land uses.

The prices used as a basis of calculation in this study were from 2012. Preferably, calculation should use annual average prices of ten-year series for all inputs and outputs of the systems expressed as constant prices to reduce the price volatility bias. However, due to lack of reliable time series data and time constraints, this study employed a single year's price. For the analysis the study also uses several assumptions based on the macroeconomic parameters 2012 that are presented in Table 5.

TABLE 5. MACRO-ECONOMIC PARAMETERS, 2012

Parameters	March 2012
Exchange rate*	US$1 = 9,068.73 IDR
Wage rate in Central Sulawesi**	IDR 50,000 per person day
Real interest rates (interest rates for working capital credit)***	12.56%

Source:
* Based on the average exchange rate Jan-March 2012 from http://fx.sauder.ubc.ca/
** Agricultural wage rate based on information from farmer interviews
*** Interest rates for working capital based on information from Bank Indonesia

Interest rate is the discount factor used to value future cash flows in current term. A private discount rate of 12.56 percent was chosen which is considered as a lower bound for the actual cost of capital for smallholders in the area under study.

Due to the lack of data and time limitation, the study only analyzed private values, which refers to observed revenues and costs reflecting market prices received or paid by farmers/land operators, merchant and processors in the systems. To estimate the opportunity cost of different land use types, the simple calculation below was employed:

$$\frac{NPV_{after} - NPV_{before}}{Cstock_{before} - Cstock_{after}} \quad \text{InUS\$ / t } CO_{2}\text{ eq}$$

Carbon uptake in biological sinks is measured in units of C, while emission reductions are measured in units of CO_2 equivalent. The ratio of the molecular weight of CO_2 (44) and atomic weight of carbon (12) (i.e., 3.67) gives the conversion factor for these measurements. In other words, 1 tC = 3.67 tCO_2.

"Before" meaning the condition before the land use changed, for example in year 2000 the land use was primary forest with NPV= x US$/ha and C stock=at C/ha, then in 2012 the area converted into plantation (hence the condition after the land use changed) with NPV=y US$/ha and c stock=btC/ha. Therefore, the opportunity costs will be: (Y-x/b-c)*3.67 tCO_2.

4. Opportunity Costs of the Main Land Use Systems in Central Sulawesi

4.1 Selected Land Use Systems

Based on the analysis of spatial and statistical data as well as field observation, several land uses have been selected (see Table 6). The choice of land use types for analysis should take into account the carbon as well as their contribution to the regional economy. The land use classification should also be in line with the land class framework used in proposed MRV systems. In the study only six principal land use systems are selected and analyzed for opportunity costs: logging, palm oil, cocoa, coconut, clove, and paddy field. Some unselected land use types such as mining are also important, but the mining sector is quite complex and requires more complex datasets and information, particularly for small-scale community mining, hence a distinct and more detailed study is recommended. There are also food crop systems scattered across the region, which produces chili, cabbage, corn and other vegetables. However, the present study does not cover the latter, due to time and resource limitation. It should be noted that the selected main land uses cover 24% of 6 million ha.

TABLE 6. LAND COVER AND SELECTED MAIN LAND USES IN CENTRAL SULAWESI

Land Cover	Size (Ha)**	Selected Land Uses	Estimated Carbon Density (t C/ha)	Scale of Operation
Primary Forest	2,554,789	Undisturbed Forest	195.4	State
Secondary Forest	1,751,963	Logging (about 867,555 ha)*	169.7	Large Scale
Plantation	126,680	Palm oil (about 53,703 ha)*	40	Large scale
Mixed Agriculture (agroforestry)	587,707	Cacao (about 224,471 ha)*	29.3	Smallholder
		Coconut (about 175,553 ha)*	30.7	Smallholder
		Clove (about 43, 199 ha)*	63	Smallholder
Paddy Field	103,817	Paddy Field	5	Smallholder
Dry Land Agriculture	433,425		8	
Settlement	29,341		1	
Mining	11,894		0	
Shrub	363,928		15	
Bare land	41,356		0	
Grassland	30,890		4.5	
No Data	2,565		n.a.	

Source: *BPS, 2011; ** Directorate of Forest Inventory and Monitoring, Ditjenplan, MoFor (2011), 2011

Based on the land cover map, the concept of 'forest area' is divided into two main categories that are primary forest and secondary forest. From these categories, some areas are so-called areas with rights attached, meaning that a third party has authority to manage the area for forestry related to industries such as HPH or HTI. Some other areas are also managed as national park, wild life reserve or protection forest, which legally should be conserved. Under this study, the area is categorized as a single land use class. Logged-over areas are one category of secondary forest and the changes from undisturbed forest to logging areas are considered as degraded. Some areas of forests do not have any legal rights attached, which could be categorized as undisturbed forest (in primary forest areas) or ex-HPH/logged over areas (in secondary forest areas). Undisturbed forest that is mostly located in remote area is most likely more secure from human disturbances. However, most logged over forests are prone to disturbance both caused by human activities and natural events such as fire.

From the land cover map, agricultural land is differentiated into several categorized plantations, mixed agriculture, paddy field, and dry land agriculture. Under this study, palm oil plantation falls under plantation category, whilst cacao, coconut and clove could fall under plantation or mixed agriculture. However, the profitability analysis only focuses on the monoculture systems. Hence, plantation agriculture is disaggregated into four main land uses, namely cocoa plantation, coconut plantation, palm oil plantation, and clove plantation. Figure 6 shows typical main land uses in Central Sulawesi.

FIGURE 6. TYPICAL MAIN LAND USES IN CENTRAL SULAWESI

a) Paddy Field

b) Smallholder Cacao Plantation

c) Smallholder Coconut Plantation

d) Large Scale Palm Oil Plantation

Photo by: Y.Wulan, 2012

Most production forest across Central Sulawesi is listed as logging concessionaries (IUPHHK-HA or HPH). Some 23,000 hectare of the production forest in five districts has also been allocated for community timber plantation (HTR). Currently, there are thirteen logging concessions and two permits for a timber plantation (IUPHHK-HT); the total area for these permits covers about 867,555 hectare scattered in eight districts (Baplan, 2012). However, since five years most logging concessionaries have temporarily stopped their operation, meaning no timber has been harvested. The current official operation cost for logging is estimated at over US$67/$m^3$ but average production is quite low, about 10 m^3/ha. This high cost coupled with low production can be explained by old equipment being used and hilly topography. The association of logging concessions (APHI) also remarked high and unpredictable social costs, which occur when the area is not 'clear and clean'[6]. Some logging areas have overlapping permits with mining operations or plantation concessions, and some areas have been claimed or are managed by communities. Therefore, most permit holders opt to temporarily halt the production until market condition improves.

The timber market from logging concessions also hardly competes with timber from IPK and illegal sources. The margin of timber sold from IPK and illegal logging is higher due to lower production costs. The operational costs for logging concessions are higher due to numerous obligations to be fulfilled by the companies such as royalties, approval for documents planning e.g. RKT, AMDAL, and obligation for selective cutting and replanting. These obligations mainly exist to ensure the sustainability of forest managed by HPH, but in practice, uncertain land use planning, tenure conflict and weak governance leads to high costs, unsustainable forest management as well as disincentives for improving forest management by the private sector. Since logging is still an important activity in Central Sulawesi, it is selected for further analysis. With the right policies and incentives, logging activities could meet wood demand for both

[6] "Clear & clean" status means that the area has established boundaries supported by local/customary rules and official regulations, and there is no conflict or outstanding claims over the land.

domestic and international markets, reducing illegal logging, and preventing fire where it is likely to happen, that is in unmanaged forest.

Plantation agriculture is also an important land use in Central Sulawesi Province. Plantations cover about 126 thousand hectare that can be categorized into two groups: large scale and small-scale plantations. The main commodities in Central Sulawesi in terms of land area, as well as economic contribution for plantation agriculture, are cocoa, coconut, clove and palm oil. Cocoa, coconut, and clove plantations are usually managed by small holder farmers (less than 5 ha), while palm oil is managed by large-scale companies. Some smallholder plantations are managed as agroforestry systems (also referred to as mixed gardens).

Cocoa and coconut are the main cash crops in the region. Central Sulawesi is the largest producer of cocoa in Indonesia and most of the product is exported as unfermented cocoa beans. The large expansion of cocoa across Central Sulawesi started in the 1970s, but it has expanded rapidly since the 1990s; it increased from about 15,000 hectare to more than 200,000 hectare in 2010. Currently, most gardens have been active for at least 25 years or more and the productivity has dropped by half, with the average productivity per hectare now being about 800 kg. In addition to the age of plantations, pests and diseases have also become a major problem for productivity of cocoa in Central Sulawesi. The poor quality of cocoa bean is also low due to limitation of farmers' knowledge in garden management as well as post-harvesting processing.

The main product of coconut plantation in Central Sulawesi is copra. The province is the third largest copra producer in Indonesia which produced more than 200,000 tons in 2011 in total area 142,000 ha. Coconut plantation stretch across the districts in the province, but the largest is situated in Donggala District. Most of the copra is shipped to Surabaya and some to Manado, North Sulawesi.

Clove has been a high-value agricultural commodity in Central Sulawesi since the 1870s. Clove is largely used in cigarettes and the pharmaceutical industry and is also the main ingredients for essen-

tial oils. The prices are very attractive to farmers and the older the tree the higher the productivity. The common clove species found in the region are *zanzibar*, *sikotok*and *siputih*.

Palm oil plantations have been introduced in Central Sulawesi relatively recently. In 2010, palm oil plantations covered about 1,608 hectare across four districts, which represent an increase of about 17 percent compared to 2006. The productivity of palm oil in this region is very low, which is about 6 tons per hectare per year.

The area of paddy field in Central Sulawesi is about 103,817 hectare with production in 2010 of 957,107 tons. The average paddy field holding per household is less than 0.5 ha; it is mainly maintained for self-consumption rather than for income.

4.2 Profitability

To assess the profitability of land uses, the study used two indicators: (1) return to land –the net present value (NPV) of the difference between benefits derived from outputs and cost of labor, capital and purchased inputs; (2) return to labor – the wage rate at NPV equals to zero. The value of family labor is included in the calculation since labor used in the systems represents foregone earnings in other activities even if they do not require cash outlay. Table 7 shows the estimates of both indicators. Other indicators that are presented in the table are NPV of establishment cost and years to positive cash flow. Cost of establishment is defined as costs prior to positive cash flow. These two indicators are particularly important for land use systems with perennial crops. The analysis of cash flow constraints involves a multi-year assessment to examine whether investments required by these systems are barriers to adoption by smallholder farmers. All the indicators are generated from farm budget analysis, which evaluated private prices.

TABLE 7. PROFITABILITY OF SELECTEDLAND USES
IN CENTRAL SULAWESI PROVINCE

Land Cover	Size (Ha)**	Selected Land Uses	Estimated Carbon Density (t C/ha)	Scale of Operation
Primary Forest	2,554,789	Undisturbed Forest	195.4	State
Secondary Forest	1,751,963	Logging (about 867,555 ha)*	169.7	Large Scale
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Settlement	29,341		1	
Mining	11,894		0	
Shrub	363,928		15	
Bare land	41,356		0	
Grassland	30,890		4.5	
No Data	2,565		n.a.	

Source: Author's calculation

All the systems show positive NPV and also yielded a return to labor higher than daily agricultural wage rates (ranging between IDR 56,000 and 190,000 per person day). Positive NPV shows that all selected land use systems are profitable.

Palm oil plantation has the highest profitability as well as return to land (IDR 72 million/ha/yr). This land use system is mostly operated by large-scale companies and is relatively newly introduced in the region. However, the wage rate for plantation workers is almost four times below the return to labor (IDR 190,236 per person-day compared to IDR 190,236 per person-day). Palm oil plantation is currently viewed as the most profitable land use system in Indonesia. However, in Central Sulawesi Province the productivity is quite low compared to the productivity of palm oil plantations in Sumatra and Kalimantan islands. Therefore, planning to expand this commodity across the province must be complemented by land suitability studies and environmental impact assessments. Furthermore, social considerations should also be taken into account, such

as local livelihood, local rights and tenure arrangement, and poverty reduction.

Commercial logging is also profitable although returns are lower than palm oil plantations. The system also has the smallest establishment cost since it can provide positive cash flow in the first year of operation. Despite the system being profitable and having lower establishment costs, many companies are almost inactive. Logging concessions must meet a dissuasive list of obligations. Complying with such obligations is costly and often avoided by some companies, hence, making logging operation unsustainable. Additionally, timber from the logging concessions also faces competition in terms of price with illegal timber in the market.

Smallholder coconut plantation has the lowest profitability and also requires the longest time to reach positive cash flow. The productivity of smallholder coconut system is quite low given the fact that many trees are old and plantations need to be regenerated. Due to time and cash flow constraints, the cost of establishment is a barrier for farmers to renew the system.

Profitability of paddy per hectare in the region is quite high, that is IDR 30 million per ha per year. However, most farmers have less that 0.25 ha per household and the output is mainly for self-consumption. The paddy systems are purposely maintained for securing their staple food rather than for cash income. The paddy system assessed in this study used a semi-technical irrigated system[7], so the productivity per hectare is high and farmers generally have three harvesting periods per year. The system is quite intensive and requires lots of labor, fertilizers and chemicals.

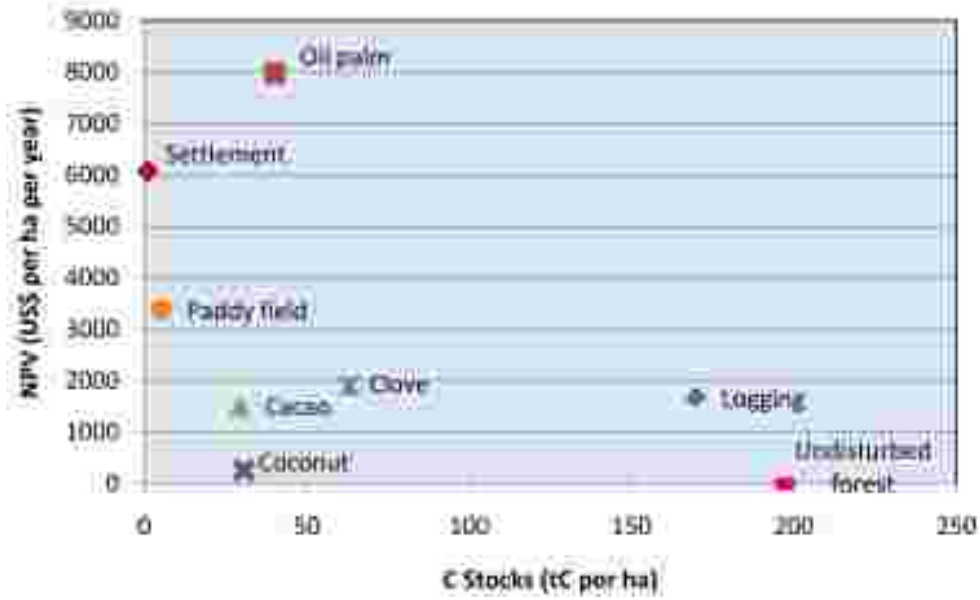
Cocoa and clove plantations are also profitable; however, both systems have high establishment costs. In the past, both systems were established with support from government trough incentive programs. For instance, the government provides planting materials, fertilizers and tools for the first one to three years. Some programs also provide funds to cover labor for land preparation. Some plantations are also established though low interest rate credit,

[7] Semi-technical irrigation systems are characterized by permanent canals and few control or measuring devices. The government usually controls the primary canals, which are equipped with measuring devices, while the distribution systems next to those canals are not equipped with measuring devices.

which could be considered if the government is planning to improve land productivity by rejuvenating old plantations or utilizing fallow/ idle land. During 2010-2014, government though Ministry of Agriculture is also planning to carry out such programs (MoA, 2009).

This study does not cover other land uses such as settlements or mining, since these activities are clearly not going to be affected by carbon financing. However, the NPV represented by the establishment of transmigration areas is about IDR 55 million (KOMPAS, June 27, 2006: Rp 14M per 2500 sq m in Dewi et al., 2010). Such programme needs further studies, as some local governments in Java have agreements with local government in Kalimantan and Sulawesi Island to continue the programme in the next few years (KOMPAS, February23, 2012). Figure 7 presents the NPV of different land uses in relationship with its carbon stock per ha.

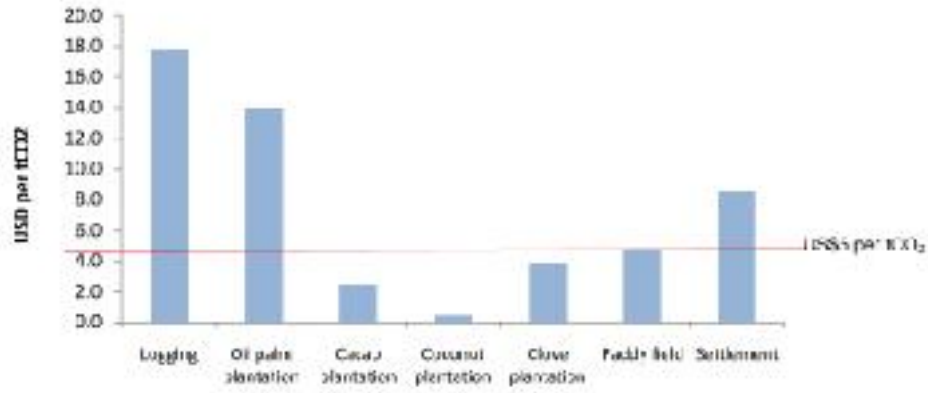
FIGURE 7. NPV AND C STOCKS OF DIFFERENT LAND USES IN CENTRAL SULAWESI



From the profitability study, it is indicated that the opportunity cost of various land use system in Central Sulawesi ranges from US$0.4 to 17.8 per tCO_2 as shown in Figure 7 (see also Table 6 for C Stock and Table 7 for NPV). Using a figure of US$5/$tCO_2$ as a reasonable value for carbon emission reduction in Indonesia

(Swallow et al., 2007; Grieg-Gran, 2006), reducing emissions resulting from converting forest to cocoa, coconut and clove plantation as well as paddy field would be easily compensated. Preventing forest conversion to these four land use systems would reduce emissions by 654 tCO_2 per hectare on average (see also Table 6). Based on the calculation the opportunity cost from natural forest to logging is the highest (US$17.8 per tCO_2), since the study assumes that NPV from natural forest is zero. However, operating sustainable forest management of existing forest is widely known as the cheapest REDD+ option. It is considered as economically and timely efficient because it will reduce emission, maintain carbon reservoirs, produce timber and provide employment for forest communities.

FIGURE 8. THE OPPORTUNITY COSTS OF VARIOUS LAND USE SYSTEMS IN CENTRAL SULAWESI



However, in addition to these numbers, transaction and implementation costs, including monitoring costs should also be taken in account. At the moment, information on transaction costs remains uncertain and there is no consistency in how data on transaction costs are collected (Wertz-Kanounnikoff, 2008).

5. Concluding Remarks

The profitability assessment selected six land use systems representing the main land use systems in Central Sulawesi Province. Some other important land use systems such as mining were not included in the assessment because they require complex and extensive data and information, and in any case, it is obvious that carbon revenues cannot compensate losses from mining.

Characterization of land use systems based on land cover data was provided by the Directorate of Forest Inventory and Monitoring, Ditjenplan, MoFor. Some obstacles in determining land use systems are the fact that land cover definition is distinct from the term land use. Ditjenplan classifies land cover types in Central Sulawesi into 22 land cover classes. However, plantation is classified as one unique class. Some of the land systems indeed could be quite similar in satellite imagery, but are quite different in terms of profitability. Therefore, for the purpose of this study, data from satellite imagery are combined with the results from analysis of statistical data as well as field observation. That being said, to improve the accuracy, extensive and intensive ground truthing are recommended.

With regard to carbon data, the study mainly relies on data provided by the Directorate of Forest Inventory and Monitoring, Ditjenplan, MoFor. However, to distinguish different carbon stocks of various 'plantation' types the study depended on literature review.

The analysis period of the land use systems is 25 years production scenario at 12.5 percent discount rate. From the profitability study, palm oil plantation stands out as the most profitable system in Central Sulawesi which reaches a land return of about IDR 72

million per hectare (or US$7,973/ha); whilst coconut plantation is the lowest at IDR 2.4 million per hectare (or US$262/ha).

Commercial logging is also profitable with an NPV of about IDR 15 million per hectare (or US$1,676/ha). However, despite the system being profitable most logging companies are inactive because of two main reasons. First, the list of obligations to be met by logging companies is demanding and often creates unpredictable and high costs. Second, the profit from timber sales is very low due to the competition with timber from IPK and illegal sources.

The study indicated that the opportunity cost of various land use system in Central Sulawesi ranges from US$0.4 to 17.8 per tCO_2. To produce an abatement cost curve, however, further analysis is needed using GIS data that are able to match the land use classes with the selected land use types.

The implementation of REDD+ in Central Sulawesi should involve a mix of policies related to land use and spatial planning, forestry and agriculture. Law enforcement and improving forest governance would be needed to support a mechanism of simple incentive such as REDD+ payments.

6. Implications and the Next Step for REDD+

The study was able to identify the province's unique geographical and physical characteristics, and comparative advantages and disadvantages with other provinces, which shape the landscape of the current economic activities. The data also provide valuable guidance in planning for REDD+.

REDD+ activities make greatest economic sense where the alternative land uses are cocoa, coconut, clove, or paddy, since the opportunity costs of those land uses are low compared with anticipated values of forest carbon. Therefore, priority areas for REDD+ interventions in Central Sulawesi should be areas with the following characteristics:

- Current or imminent threat of deforestation due to cocoa, coconut, clove, or paddy
- High carbon density
- High biodiversity value
- High poverty rate among local stakeholders
- Other considerations (such as watershed value)

Cocoa plantation is one of the main land uses that has been expanding in area. In Central Sulawesi, being the largest producer of cocoa in Indonesia, the plantations started in the 1970s and expanded from 15,000 hectares to more than 200,000 hectares by 2010. However, the productivity has declined by half, due to the age of plantations, pests and diseases. The study also indicates a lack of knowledge in plantation management and harvesting processes.

As 40% of the province's economy and 60% of the employment rely on the agriculture sector, supporting the productivity of cocoa plantation will have an impact on many communities in the

province. REDD+ can provide incentives to protect forests instead of expanding the plantation, while increasing the productivity of the plantation, if technical assistance and knowledge on better management of plantation were provided as benefits from REDD+.

Unlike many other provinces, logging is not a major driver of forest degradation in Central Sulawesi. Competition with other provinces such as those in Kalimantan, and high transportation costs due to the mountainous terrain of Central Sulawesi, result in most of the concessions being inactive at present, despite the study showing that the opportunity cost of logging (US$/t$CO_2$) is the highest among the main land uses. Currently, even small logging concessions (IPK) and illegal logging are in declining trends. The very high opportunity cost of logging needs to be qualified, since logging and REDD+ are not mutually exclusive land uses, as is the case for most other land uses analyzed. Logging, particularly reduced-impact logging, can yield significant economic returns while simultaneously generating REDD+ revenues. The implication for REDD+ planning is that improved management of logging concessions and the promotion of reduced-impact logging procedures is a "no-regrets" policy which would be beneficial even without the opportunity of REDD+ revenues.

Many parts of Central Sulawesi are not suitable for large scale plantations such as palm oil. Consequently, even though these activities have high opportunity costs, future trends are not likely to see significant increases in area of such plantations, and the trend may even be for a decline in area.

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Appendix 1. Questionnaire

QUESTIONNAIRE

Characterization Land Use System in Central Sulawesi

2012

No Responden	

A. Plot Description		
1	Land use type[1)]	
2	Name of the owner/manager	
3	Village Name	
4	Time/distance from the nearest village	..... hours ..... km
5	Land status & function	
6	Main crop	
7	Production cycle	..... year
8	Mature period	
9	Plot size [2)]	
	a. Local unit b. m^2/ha	

[1)] Paddy Field (irrigated paddy, rainfed paddy), dryland, plantation cocoa/ coconut/oil palm/rubber (monoculture, simple agroforest, complex agroforest), Shrub, etc.

[2)] Based on farmer information and GPS.

B. Plot History

1	Land acquisition	
	a. Method of land acquisition	(1) Land clearing (2) Purchased (3) Inheritance (4) Bequest (5) Others ……
	b. If it is bought, when and the price at that time	Rp (Year of purchasing .....)
2	Land use	
	a. Previous land use	(1) undisturbed forest, (2) logged-over forest (3) shrub (4) abandoned garden (5) unproductive land (6) Imperatagrass land, (7) dry land, (8) paddy field, (9) others .....
	b. Current land use	1. Is there any difference with the previous land use? (1) Yes (2) No 2. If it is different 2.1 In what way? 2.2 The reason to modified the land use 3. When is it changed

C. Commodity Cultivation in the Observed Plot in the Last Five Years

1. Types of crops

Types	2012	2011	2010	2009	2008	Note

C. Commodity Cultivation in the Observed Plot in the Last Five Years

2. Crop planting pattern on the observation plot (season 20011/20012)

Month >	1	2	3	4	5	6	7	8	9	10	11	12	Note
Paddy Field													
1.													
2.													
3.													
Food Crops													
1.													
2.													
3													
4													
Horticulture													
1.													
2.													
3.													

C. Commodity Cultivation in the Observed Plot in the Last Five Years

3. Labor input during the last two years

Type of Activity	2012						2011					
	Family Labor			Hired Labor			Family Labor			Hired Labor		
	head of fam	wife	other	male (M)	female (F)	other	head of fam	wife	other	male (M)	female (F)	other
3.1 Land preparation - Slash - Burn - Plow 1 - Plow 2 - Hoeing 1 - Hoeing 2												
3.2 Nursery												
3.3 Planting												
3.4 Maintenance												
a) Weeding b) Land conservation - Bench terracing - Maintenance												
3.5 Crop maintenance a) Fertilizer b) Pest control c) Pruning												
3.6 Harvesting												

Note about labor hire system for harvesting espc. cocoa/coconut/palm oil and timber

C. Commodity Cultivation in the Observed Plot in the Last Five Years

4. Harvesting product in the last few years

Commodity		2012	2011	2010	2009	UNIT
Seasonal Crop						
Perennial Crop (includingcocoa/coconut/oil palm)						
Timber						
	Fire wood (m^3)					

D. Land management in early year

1. What did you do once the acquired?

a) Land was cleared for planting perennial crops cocoa/ coconut/oil palm b) Land was cleared for planting food crops (eg. paddy) c) Land was cleared for planting horticulture crops (eg. vegetables) d) Land was cultivated as former management (no significant changed) e) Rejuvenation of old plantation	Note:

2. Labor requirement for land preparation

Activity	Working Days	Number of Labor		
		Family Labor	Hired Labor	Tools Employed (Unit)
(1) Slash				
(2) Burn				
(3) Hoeing 1				
(4) Hoeing 2				
(5) Plow (1)				
(6) Plow (2)				
(7) Rejuvenation				
(9) Other activities				

3. Weeding (how many times a year) ... ...

Activity	Working Days	Number of Labor		
		Family Labor	Hired Labor	Tools Employed (Unit)

E. Planting Activity

Type (Species/ Variety)		Number of seedling/ stump	Price per Unit	Planting Year[1)]	Labor Involved			
					Working Days	Family	Hired	Wage per ps-day
Seasonal Crop								
Perennial Crop (includingcocoa/ coconut/oil palm)								
Timber								

F. Crop Maintenance Activity

1. Fertilizer and Pest Control

1.1 Fertilizer	Time for application [1)]	Number	Price	Labor Involved			
				Working Days	Family	Hired	Wage per ps-day
a) Urea b) TSP c) KCL d) Manure e) Others							
1.2 Chemicals a) Pesticide b) Herbicide c) Fungicide d) Others							
2. Crop Maintenance							
2.1 Cocoa/ Coconut/ Oil Palm a) pruning b) thinning c) Others							
2.2 Other Trees a) Pruning b) Others							

[1)] Years of application

G. Harvesting

Crop Type		Output Year 1	Output Year 2	Output Year 3	Output Year 4
Seasonal Crop					
Perennial Crop (includingcocoa/coconut/oil palm)					
Timber					

H. Surveyor

01. Surveyor Name	
02. Interview Date (Day/Month/Hour)	...../...../.....
03. Source of Main Information	(1) Land Owner (2) Land Manager (3) Neighboring Farmer (4) Others .....

Appendix 2: Contributors to the Study

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